SUPPLEMENTS TO CORN FOR FATTENING SWINE

OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., MAY, 1921

BULLETIN 349

OHIO AGRICULTURAL EXPERIMENT STATION

BOARD OF CONTROL

JOHN KAISER, *President* ..... Marietta
T. C. MENDENHALL, *Vice-President* ..... Ravenna
JOHN F. CUNNINGHAM ..... Cleveland
O. E. BRADFUTE ..... Xenia
CHARLES F. KETTERING ..... Dayton
BENJ. F. MCCANN ..... Dayton
LAWRENCE E. LAYBOURNE ..... Springfield
L. J. TABER, *Director of Agriculture* ..... Columbus

CARL E. STEEB, *Secretary*

STATION STAFF

C. G. WILLIAMS, *Director*

ADMINISTRATION

THE DIRECTOR, *Chief*
WILLIAM H. KRAMER, *Bursar*
W. K. GREENBANK, *Librarian*
CLARENCE M. BAKER, B. S., *Editor*

AGRONOMY

C. G. WILLIAMS, *Director, Chief*
F. A. WELTON, M. S., *Associate*
J. B. PARK, Ph. D., *Associate*[1]
L. E. THATCHER, Ph. G., *Assistant*
C. A. PATTON, *Assistant*
C. E. DIKE, B. S., *Field Assistant*
WILLIAM HOLMES, *Farm Manager*

ANIMAL INDUSTRY

G. BOHSTEDT, M. S., *Chief*
D. C. KENNARD, B. S., *Associate*
W. L. ROBISON, M. S, *Assistant*
C. H. HUNT, A. M., *Assistant*
A. R. WINTER, M. S., *Assistant*
P. S. WHITE, B. S., *Assistant*

BOTANY

A. D. SELBY, B. S., *Chief*
TRUE HOUSER, B. S., *Asst.*, (Germantown)
FREDA DETMERS, Ph. D., *Assistant*
ROY C. THOMAS, M. A., *Assistant*
M. J. YOUNG, M. S., *Assistant*

CHEMISTRY

J. W. AMES, M. S., *Chief*
C. J. SCHOLLENBERGER, *Assistant*
MABEL K. CORBOULD, *Assistant*
RAUB H. SIMON, A. M., *Assistant*
V. H. MORRIS, A. B., *Assistant*

CLIMATOLOGY

W. H. ALEXANDER, *Chief* (Columbus)[2]
C. A. PATTON, *Observer*

DAIRYING

C. C. HAYDEN, M. S., *Chief*
A. E. PERKINS, M. S., *Assistant*
C. F. MONROE, B. S., *Assistant*

ENTOMOLOGY

H. A. GOSSARD, M. S., *Chief*
HERBERT OSBORN, D. SC., *Associate*[1]
J. S. HOUSER, M. S. A., *Associate*
W. V. BALDUF, M. S., *Assistant*

FORESTRY

EDMUND SECREST, B. S., *Chief*
J. J. CRUMLEY, Ph. D., *Assistant*
F. W. DEAN, B. S., *Assistant*
O. A. ALDERMAN, B. S., *Assistant*

HORTICULTURE

J. H. GOURLEY, M. S., *Chief*
W. J. GREEN, *Consulting Horticulturist*
PAUL THAYER, M. S., *Associate*
F. H. BALLOU, *Assistant* (Newark)
J. B. KEIL, *Field Assistant*
I. P. LEWIS, B. S., *Field Assistant*
C. W. ELLENWOOD, *Field Assistant*

SOILS

CHAS. E. THORNE, M. S. A., *Chief*
J. W. AMES, M. S., *Asso. in soil chemistry*
F. E. BEAR, Ph. D., *Associate*[1]
A. BONAZZI, B. Agr., *Assistant*
G. W. CONREY, A. M., *Assistant*[1]

FARM MANAGEMENT

C. W. MONTGOMERY, *Chief*
G. M. DEGROFT, *Assistant*
F. D. ECHELBERRY, B. S., *Office Assistant*

DISTRICT EXPERIMENT FARMS

Northeastern Test-Farm, Strongsville
D. S. KIRBY, *Foreman*

Southwestern Test-Farm, Germantown
HENRY M. WACHTER, *Manager*

Southeastern Test-Farm, Carpenter
E. C. SCHWAN, *Foreman*

Northwestern Test-Farm, Findlay
JOHN A. SUTTON, *Manager*

COUNTY EXPERIMENT FARMS

Miami Co. Experiment Farm, Troy
Madison Co. Experiment Farm, London
H. W. ROGERS, *Supt.*, London

Paulding Co. Experiment Farm, Paulding
H. R. HOYT, *Supt.*, Wooster

Clermont Co. Experiment Farm, Owensville
Hamilton Co. Experiment Farm, Mt. Healthy
W. E. WEAVER, *Supt.*, Mt. Healthy

Washington Co. Experiment Farm, Fleming
Washington Co. Truck Experiment Farm, Marietta
S. C. HARTMAN, M. S., *Supt.*, Marietta

Mahoning Co. Experiment Farm, Canfield
Trumbull Co. Experiment Farm, Cortland
J. PAUL MARKLEY, *Supt.*, Canfield

Belmont Co. Experiment Farm, St. Clairsville
C. W. MONTGOMERY, *Acting Supt.*, Wooster

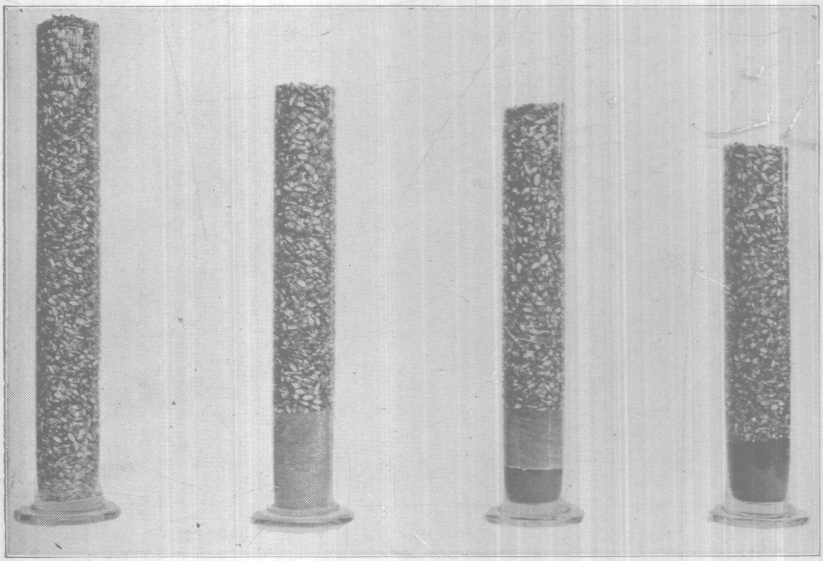
STATE FORESTS

Waterloo State Forest, New Marshfield
Dean State Forest, Steece

---

[1]In cooperation with the College of Agriculture, Ohio State University, Columbus.
[2]In cooperation with the U. S. Department of Agriculture.

CONTENTS



Left to right: In eight tests in which corn alone was fed, 5.43 pounds of feed were required for each pound of gain. When corn was supplemented with linseed meal, with linseed meal and tankage and with tankage in Experiments VI and VII averages of 4.44, 4.07 and 3.86 pounds, respectively, were required for each pound of gain produced

BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 349 MAY, 1921

SUPPLEMENTS TO CORN FOR FATTENING SWINE

W. L. ROBISON

High-protein feed desirable.—Compared with the feeding of grain alone a marked saving in feed as well as more rapid production is brought about by using some feed high in protein with the grain. Among the feeds of this character commonly used dairy by-products and tankage have given the best results. As there is an insufficient supply of these to furnish all the protein needed to properly balance the corn and other carbonaceous feeds that are used for feeding swine it is desirable to find feeds that will take their place or serve as a partial substitute for them.

Supply of tankage and dairy by-products inadequate.—In slaughtering, cattle yield approximately 1.02 percent of tankage and swine, 2 percent of tankage that can be used for feeding purposes if handled in the right way.* The total number of cattle, calves and hogs slaughtered in 1918 at establishments under federal meat inspection were 11,828,549, 3,456,393 and 41,214,250 head, respectively. Their estimated average weights in the order named were 929.7, 153 and 213.6 pounds.† If tankage is manufactured at all of these establishments the approximate production from cattle and swine killed by them was 146,889 tons.

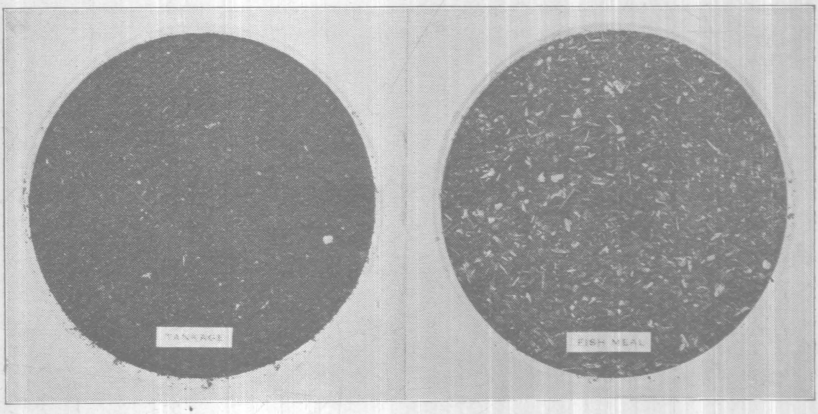
The larger packing companies buy some material for the manufacture of tankage from smaller companies that do no interstate business and so are not under federal inspection. Rendering plants are another possible source of material for the production of tankage. It is estimated that for 1918 the slaughter of federally inspected animals was 75.1 percent, 44.5 percent and 59 percent, respectively, of the total number of cattle, calves and swine slaughtered. An estimate based on 75 percent of the total number of animals killed will probably more than cover the total percentage

*Figures supplied by G L Noble of Armour's Bureau of Agricultural Research

†From tables prepared by the Bureau of Animal Industry of the United States Department of Agriculture.

of slaughter from which tankage is made so that on a liberal estimate the amount of digester tankage and meat meal produced in 1918 did not exceed 172,487 tons.

A report of the Indiana State Chemist on commercial feeding stuffs gives the estimated tonnage of tankage, meat scraps and blood meal sold at retail in Indiana in 1918 as 12,344 tons. Feeding tankage, or that containing 30 to 45 percent of protein, most of which is produced by rendering plants and small packing companies, constituted 1,625 tons of this. At the close of 1918 Indiana had 6.175 percent of the total number of hogs in the United States. It is safe to assume that for the entire country the average amount of tankage fed per hog was no greater than the average amount



used by Indiana feeders. On such an assumption the total production of digester tankage, meat scraps and blood meal for 1918 did not exceed 173,568 tons. Estimated in the same way the production of feeding tankage was less than 26,313 tons.

When no other supplement is used and the amount needed by the breeding herd is included an average of at least 60 pounds of tankage is needed to bring a hog to the weight of 200 pounds. Because of its lower protein content about twice as much of feeding tankage as of digester tankage is needed to balance the ration. With the most liberal estimated production given the total output of tankage in 1918 was enough for not more than 8.3 percent of the total number of hogs slaughtered during the same year.

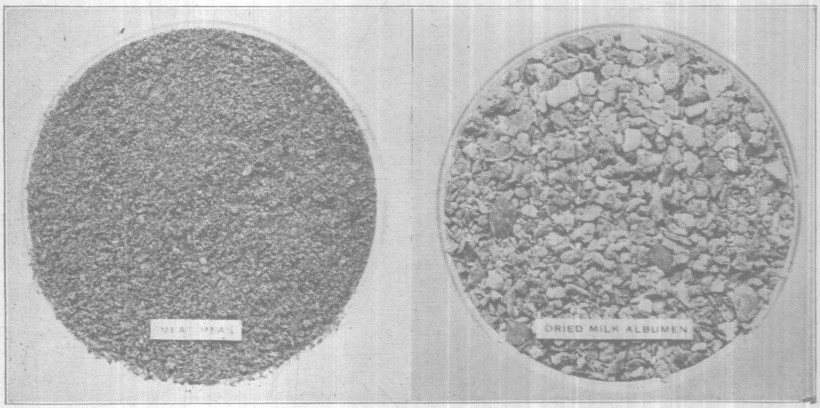
From statistics available nothing more than a rough approximation of the skimmilk and other dairy by-products fed to swine can be made but as nearly as can be determined the total production in 1918 that was not used for other purposes would have supplied

not more than 16 percent of the total number of hogs produced for slaughter. Even less than this amount was utilized, for large quantities of whey, of skimmilk and of buttermilk are still poured down the sewers of cheese factories, milk plants and creameries.

Something of the importance of the problem is realized when it is seen that for 70 to 75 percent of the total swine production feeds other than those of the dairy and packing industries must be depended upon to supplement the grain fed.

PURPOSE OF EXPERIMENTS

The objects of conducting the experiments herein reported were (1) to find the comparative feeding values of a number of



supplements, including some of the newer and less common ones, particularly those the output of which is likely to increase to such an extent as to give them a place of considerable economic importance and (2) to determine if possible more effective ways of utilizing the seeds and the by-products of plant origin having a high-protein content than feeding them as the sole supplement to corn and other carbonaceous feeds.

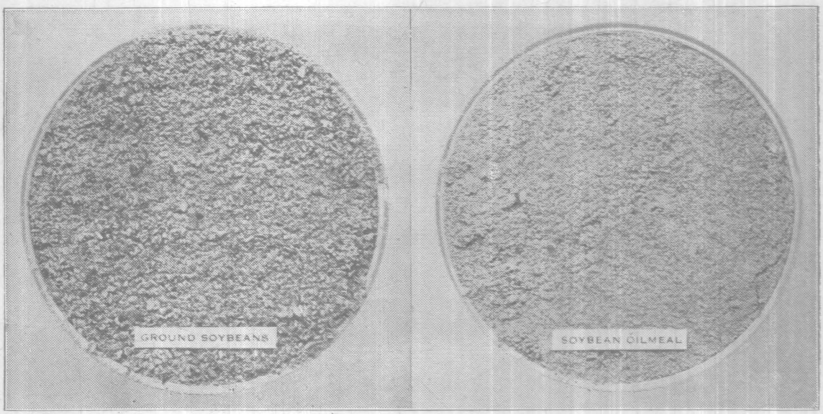
DESCRIPTION OF SUPPLEMENTARY FEEDS

The **skimmilk** used in Experiment IV was separator milk supplied by the Dairy Department of the Experiment Station. Usually it was fed while still sweet or only slightly acid.

Dried milk albumen is a by-product of the milk-sugar factories that first appeared on the market about 1900 and has since then steadily increased in output. It is dried skimmilk from which milk sugar has been removed. A high percentage of protein and of ash is left in the feed.

Digester tankage of good grade, sold to contain 60 percent of protein, was used. Digester tankage is made from blood, fresh meat scraps, fat trimmings including the cracklings and scrap bones and includes as well a small amount of glandular material and tissue of the internal organs. These are thoroughly cooked in steel tanks by steam under pressure. This process liquifies the fat, as much of which as possible is then drawn off. After being dried and ground the material remaining is sold as tankage.

The **meat meal** used was higher in protein and fat and lower in ash and crude fiber than the tankage. It differed from the tankage by being made from meat cuttings consisting exclusively of muscular and fatty tissue. It contained no tissue of the internal organs and no skeletal material.

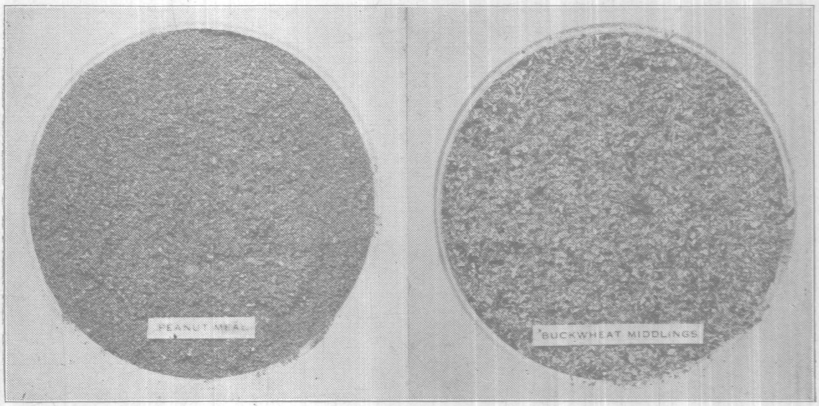


The **fish meal** used was supplied by the Bureau of Animal Industry of the United States Department of Agriculture. They report that it is made from whole fresh Menhaden fish, which are a non-edible ocean fish. These are first cooked, then pressed to extract as much oil as possible, then dried in a steam dryer, from which they come in the form of what is called fish scrap. Upon being ground the fish scrap is known as fish meal. Heretofore this fish product has been used almost entirely for fertilizer. As its high feeding value becomes known there will be a growing demand for it for feeding purposes. Since Menhaden fish are abundant and more can be caught as the sales of the fish products (oil and meal) increase, the available supply of the meal will doubtless grow with the demand.

Peanut meal and peanut feed are the by-products remaining after the extraction of part of the oil from peanut kernels and

whole or partially hulled peanuts. Depending on the method used in extracting the oil and the proportion of hulls remaining, the protein content varies from less than 30 to more than 45 percent. Peanut hulls are more than half fiber and have little or no feeding value. As the proportion of hull increases, the worth of the feed diminishes. Care should be taken to select peanut meal that has a high protein content and a low percentage of crude fiber. Peanut feeds containing the same percentage of protein sometimes vary as much as 10 percent in the amount of crude fiber carried.

Soybean oilmeal is the ground residue remaining after oil has been extracted from soybeans. The oil is of a semi-drying character and is suitable for a number of commercial uses. It may be extracted by the means of pressure or by the use of solvents



such as benzol or naptha. Apparently the pressure method is the one most extensively used at the present time. The beans are first heated then ground and pressed while still warm. In passing through the press itself they are subjected to a fairly high temperature. This heating tends to increase the flow of oil. Because of variations in the composition of the beans, and the thoroughness with which the oil is removed, the meal may vary considerably in its oil content and in the percentage of protein contained. For feeding purposes soybean oilmeal low in oil or fat and high in protein is to be preferred.

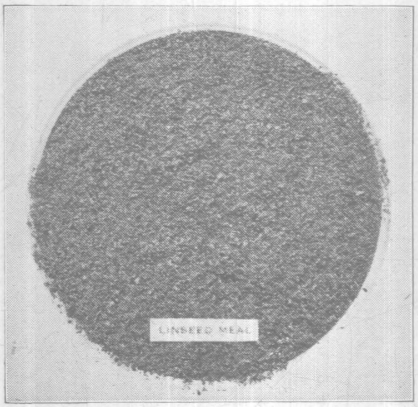
The **soybeans** used in the experiments were grown on the Station farm and were of good quality. They were ground in such quantities as would be fed within a few weeks' time.

The **linseed meal** was the old process, finely-ground oilmeal, guaranteed to contain 30 percent or more of crude protein.

In securing **wheat middlings** for the experiments an attempt was made to secure a good grade of white middlings as free from bran as it was possible to get them at the time.

Buckwheat middlings come from that part of the kernel just beneath the hull which is separated from the flour in milling. The black, woody hulls of buckwheat have little or no feeding value and in the feed for pigs are even detrimental. In order that they may be disposed of the hulls are usually mixed with the middlings. Some difficulty was experienced in obtaining middlings practically free from hulls.

Cocoanut meal or **copra** is the ground product remaining after a part of the oil has been extracted from the fleshy portion of the cocoanut. Before the war this product was largely marketed in Europe, but during the last few years some of it has been finding a market in this country.



Corn germ meal.—In the manufacture of starch, glucose, hominy and other corn products the germs are removed from the corn kernel. Upon the extraction of a part of the oil from the germs corn oil cake remains. When the cake is ground it is designated corn oil cake meal, hominy hearts, corn oil-meal or corn germ meal. The association of Feed Control Officials has accepted the latter name for this product. There are two fairly distinct types of corn germ meal. In the manufacture of hominy, corn flour, corn meal and products in which the same process is used the germ is separated wholly by mechanical means. In the production of starch, glucose, corn syrup and other corn products the germs are first loosened by a dilute acid treatment. The two classes of corn germ meal result from these two methods of separating the germs from the kernels.

With the exception of the dried milk albumen and one sample of tankage which were analyzed by the Bureau of Feeds and Fertilizer of the Ohio Department of Agriculture, the analyses of the supplemental feeds reported in Table I were made by the Department of Dairying.

TABLE I.—COMPOSITION OF SUPPLEMENTARY FEEDS

	No. of samples composited	Moisture	Ash	Crude protein (N x 6.25)	Carbohydrates		Fat (ether extract)
					Fiber	N-free extract	
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Skimmilk	1	90.63	.76	3.48	.....	5.02	.05
Skimmilk (moisture free basis)	1	.....	8.11	37.14	.....	53.58	.53
Dried milk albumin	2	6.33	17.65	45.50	.70	18.82	11.00
Fish meal	1	9.17	18.66	58.25	.53	.....	7.36
Tankage	4	9.23	17.61	58.88	2.70	3.30	8.28
Meat meal	2	7.35	6.82	71.81	1.33	.....	13.62
Peanut meal	1	9.28	5.30	41.19	10.57	26.30	7.36
Soybean oilmeal	2	8.92	2.69	49.25	4.93	30.99	3.22
Soybean oilmeal	1	8.30	6.86	40.50	6.33	26.22	11.77
Soybeans	1	10.40	5.27	35.81	2.31	29.53	16.68
Linseed meal	3	9.62	6.21	34.63	7.09	35.41	7.04
Wheat middlings	2	11.71	3.76	14.90	5.07	60.76	3.80
Buckwheat middlings	1	16.20	4.61	31.22	4.07	36.76	7.14
Cocoanut oilmeal (copra)	1	11.05	6.63	20.06	9.87	45.25	7.14
Corn germ meal	1	9.88	1.93	18.81	8.46	50.75	10.17
Alfalfa hay	1	13.98	6.37	16.41	27.95	33.36	1.93
Clover hay (rowen)	1	15.42	8.59	16.57	18.52	37.55	3.35

SOYBEAN OILMEAL COMPARED WITH TANKAGE

EXPERIMENT I

In the first trial made with soybean oilmeal it was compared with tankage as a supplement to corn for feeding pigs that were on bluegrass pasture. The experiment was short, lasting only 6 weeks. Two lots of four pigs each were fed, respectively, corn 9 parts, tankage 1 part, and corn 8 parts, soybean oilmeal 1 part. Ground corn was used. The pigs were crossbred Tamworth-Durocs. Seven were 137 days of age and the other one 112 days old when the test was begun. The average initial weight was 114.4 pounds. Both lots were given a full feed of concentrates or all they would clean up readily twice daily. During the trial both lots were allowed to run on a small bluegrass plot which at the time did not furnish much green feed.

TABLE II.—EXPERIMENT I: COMPARISON OF SOYBEAN OILMEAL AND TANKAGE

July 26 to September 6, 1916

Four pigs per lot		Lot 1 Corn, 9; tankage, 1	Lot 2 Corn, 8; soybean oilmeal, 1
Average initial weight	pounds..	115.75	113.125
Total gain	pounds..	252	253
Average daily gain	pounds..	1.50	1.506
Concentrates consumed: corn	pounds..	881.55	874.222
supplement	pounds..	97.95	109.278
total	pounds..	979.50	983.500
Daily concentrates per pig	pounds..	5.83	5.854
Concentrates per 100 pounds gain: corn	pounds..	349.821	345.542
supplement	pounds..	38.869	43.193
total	pounds..	388.690	388.735

Table II gives the results secured. The soybean oilmeal made an exceptionally good showing. There was very little difference in the rate of gain or in the feed consumed. The total amounts of feed required per unit of gain were practically the same for the two lots.

EXPERIMENT II

TANKAGE, SOYBEAN OILMEAL AND GROUND SOYBEANS

Experiment II compares tankage, soybean oilmeal and ground soybeans as supplements to corn for feeding pigs in dry lot. Previous to the beginning of the experiment some of the pigs were allowed field peas and oats and some field peas and rape as forage, during which time all were fed a ration of corn 14 parts, tankage 1 part. As in the preceding experiment the pigs were full-fed, the amount given each lot being determined by the appetites of the pigs. The initial weights of the pigs, the rations fed and the results secured are shown in Table III.

TABLE III.—EXPERIMENT II: SOYBEAN OILMEAL AND GROUND SOYBEANS AS SUPPLEMENTS TO CORN

August 24 to October 12, 1916

Four pigs in each lot		Lot 1 Corn, 9; tankage, 1	Lot 2 Corn, 8; soybean oilmeal, 1	Lot 3 Corn, 24; ground soybeans, 5
Average initial weight	pounds..	103.75	103.25	103.5
Total gain	pounds..	365.0	327.5	274.5
Average daily gain	pounds.	1.862	1.671	1.401
Feed consumed: corn	pounds..	1,163.7	1,033.333	860.69
supplement	pounds..	129.3	129.167	179.31
total	pounds..	1,293.0	1,162.500	1,040.00
Daily feed per pig	pounds..	6.597	5.931	5.306
Feed daily per 100 pounds of live weight	pounds.	4.416	4.113	3.850
Feed per 100 pounds gain: corn	pounds..	318.822	315.522	313.548
supplement	pounds..	35.425	39.440	65.323
total	pounds..	354.247	354.962	378.871

Both the rate of gain and the feed required per unit of gain by the lots receiving tankage, soybean oilmeal and ground soybeans, respectively, were in the order in which the supplements are named. There was practically no difference, however, in the feed consumed for each 100 pounds of gain, produced by the first two lots.

In comparison with the corn and tankage ration the pigs fed corn and soybean oilmeal did not gain as rapidly as did those in Experiment I that were allowed pasture in addition to the concentrate ration.

Soybean oilmeal proved a more valuable supplement to corn than did the ground soybeans. The pigs fed the ration containing

the former gained 19.3 percent more rapidly and required 6.3 percent less feed per unit of gain than those fed ground soybeans. That the ration containing the soybean oilmeal was more palatable than the one containing the ground soybeans is indicated by the larger amount of feed consumed daily for each 100 pounds of live weight.

COMPARISON OF SUPPLEMENTS FOR SELF-FEEDING IN DRY LOT

EXPERIMENT III

The pigs used in Experiment III were from 80 to 96 days of age at the beginning of the test. Previous to the starting of the experiment, 18 of the pigs were fed a ration of corn 1 part, skimmilk 3.5 parts; 12 of them a ration of corn 5 parts, middlings 3 parts and tankage 1 part, and six of them a ration of corn 8.6 parts, linseed meal 2 parts and tankage 1 part. During lactation the sows received the same rations as their pigs. Until the beginning of the experiment the pigs were on bluegrass pasture.

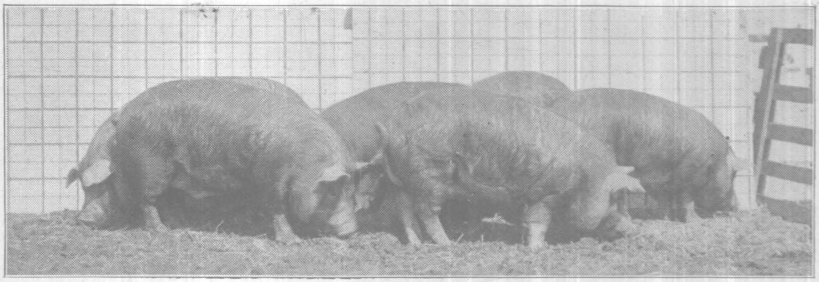
All of the lots were self-fed ground corn and the supplement in separate compartments of the feeders. At the time the pigs were weighed each week the feed remaining in the feeders was also weighed so that the amount of corn and of supplement consumed weekly and the proportions in which they were taken might be determined. All lots had salt, ground limestone and ground rock phosphate before them in separate divisions of a box. The supplements used were meat meal (see page 139), soybean oilmeal, ground soybeans, linseed meal and tankage. The experiment was continued for 14 weeks with the results as shown in Table IV.

TABLE IV.—EXPERIMENT III: COMPARISON OF SUPPLEMENTS TO CORN FOR SELF-FEEDING IN DRY LOT

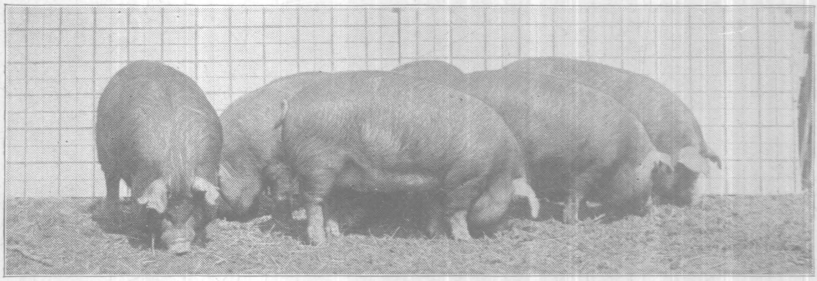
December 20, 1916, to March 28, 1917

Six pigs per lot	1 Corn and meat meal	2 Corn and soybean oilmeal	3 Corn and ground soybeans	4 Corn and linseed meal	5 Corn and tankage
Average initial weight.....pounds..	54.417	54.167	54.167	54.25	53.5
Total gain .....pounds..	769.0	783.5	688.0	747.5	913.0
Average daily gain.... ... .pounds..	1.308	1.332	1.170	1.271	1.553
Feed consumed: corn..... ....pounds..	2,962.0	3,034.0	2,931.0	3,174.5	3,359.0
supplement .....pounds..	225.5	182.5	113.5	126.0	229.5
total .....pounds..	3,187.5	3,216.5	3,044.5	3,300.5	3,588.5
Daily feed per pig; corn.....pounds..	5.037	5.160	4.985	5.399	5.713
supplement .....pounds..	.384	.310	.193	.214	.390
total ....pounds..	5.421	5.470	5.178	5.613	6.103
Feed daily per 100 lbs. weight... pounds..	4.575	4.590	4.644	4.816	4.710
Feed per 100 pounds gain: corn ..pounds..	385.175	387.237	426.018	424.682	367.908
supplement..... .. .... pounds..	29.324	23 293	16.856	16.856	25.137
total.....pounds..	414.499	410.530	441.538	441.538	393.045
Parts corn to supplement.....	13.1:1	16.6:1	25.8:1	25.2:1	14.6:1

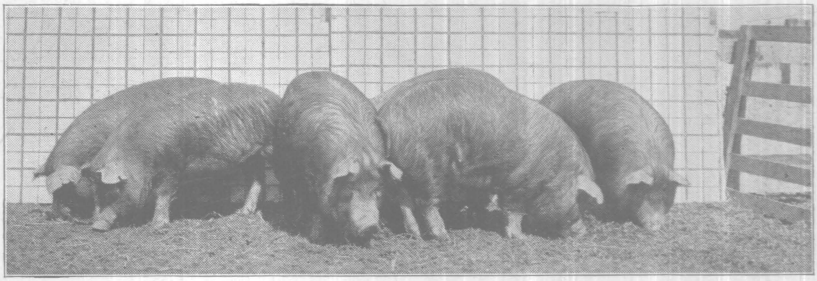
A 73-pound pig in Lot 2 was replaced with a 69.5 pound pig on January 3.



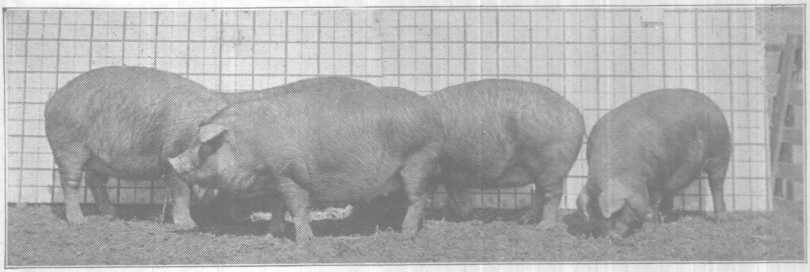
Lot 1, Experiment III: Self-fed corn and meat meal separately; average daily gain 1.31 pounds



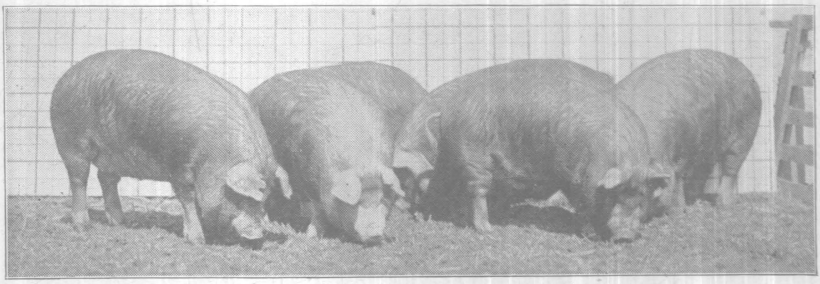
Lot 2, Experiment III. Self-fed corn and soybean oilmeal separately; average daily gain 1.33 pounds



Lot 3, Experiment III: Self-fed corn and ground soybeans separately; average daily gain 1.17 pounds



Lot 4, Experiment III: Self-fed corn and linseed meal separately; average daily gain 1.27 pounds



Lot 5, Experiment III: Self-fed corn and tankage separately; average daily gain 1.55 pounds

The pigs receiving tankage made more rapid gains and required a smaller amount of feed per unit of gain and those receiving ground soybeans gained more slowly and consumed a larger amount of feed per unit of gain than any of the other lots with which they were compared. Soybean oilmeal proved a much more valuable feed than did the ground soybeans. The pigs did not eat the ground soybeans or the linseed meal readily and failed to take a sufficient quantity to balance the corn. The soybeans and linseed meal consumed amounted to less than 4 percent of the total rations. Although higher in protein the meat meal used did not prove as efficient as tankage for feeding with corn to pigs in dry lot. Since the protein in meat meal is from a similar source and doubtless is as good in quality as that in tankage, the meat meal obviously was not as effective as was tankage in making up the deficiency of corn in other respects than the low protein content of the corn.

The lots fed ground soybeans and linseed meal as supplements consumed about the same amounts of feed per unit of gain. The linseed meal lot, however, gained more rapidly than the soybean lot.

During the last week of the experiment two of the pigs having meat meal as a supplement, two having ground soybeans and one having linseed meal became lame posteriorly. The two receiving ground soybeans gained only a half pound each for the week and the others lost in weight.

As pigs become heavier they require more feed per unit of gain. Until a weight heavier than that at which they are usually marketed is reached they also gain more rapidly (under similar treatment) as they increase in weight. Heavy hogs dress a higher percentage than do those of lighter weight. If only performance during an experiment is considered and their relative dressing percentages at the close of an experiment are not taken into account carrying pigs to a given weight and comparing the results secured is probably a better method of determining the relative merits of different rations than feeding for a given length of time.

TABLE V.—EXPERIMENT III: COMPARISON OF SUPPLEMENTS TO CORN FOR SELF-FEEDING IN DRY LOT

To a weight of 175 pounds					
Six pigs per lot	1 Corn and meat meal	2 Corn and soybean oilmeal	3 Corn and ground soybeans	4 Corn and linseed meal	5 Corn and tankage
Time required.....days..	84.0	91.0	98.0	91.0	77.0
Average initial weight.....pounds..	54.417	54.167	54.167	54.25	53.5
Total gain.....pounds..	700.0	727.5	688.0	705.5	726.0
Average daily gain.....pounds..	1.389	1.332	1.170	1.292	1.571
Feed consumed: corn.....pounds..	2,492.5	2,822.5	2,931.0	2,930.0	2,482.5
supplement.....pounds..	220.0	166.5	113.5	116.0	202.5
total.....pounds..	2,712.5	2,989.0	3,044.5	3,046.0	2,685.0
Daily feed per pig: corn.....pounds..	4.945	5.169	4.985	5.366	5.374
supplement.....pounds..	.437	.305	.193	.213	.438
total.....pounds..	5.382	5.474	5.178	5.579	5.812
Feed daily per 100 lbs. weight....pounds..	4.773	4.781	4.644	4.935	5.098
Feed per 100 pounds gain: corn..pounds..	356.071	387.972	426.018	415.308	341.942
supplement.....pounds..	31.429	22.887	16.497	16.442	27.893
total.....pounds..	387.500	410.859	442.515	431.750	369.835
Parts corn to supplement.....	11.3:1	17:1	25.8:1	25.3:1	12.3:1

A 73-pound pig in Lot 2 was replaced with a 69.5 pound pig on January 3.

Table V gives a summary of Experiment III with the results for each lot summarized to the time when the weekly weight for the lot was nearest an average of 175 pounds.

When summarized in this way the pigs allowed tankage, meat meal, soybean oilmeal, linseed meal and ground soybeans ranked in the order in which the supplements are named both in rate of gain and in economy of feed required per unit of gain.

EXPERIMENT IV

The pigs used in Experiment IV were from 89 to 102 days of age when the experiment was started December 20. Previous to the beginning of the test their dams were fed hominy feed, middlings and tankage; the pigs, after they were 3 weeks old, received the same feeds with the addition of skimmilk. Five pigs were fed in each lot. Shelled corn was used. The supplements compared were (1) tankage, (2) meat meal (see page 139), (3) soybean oilmeal, (4) ground soybeans, (5) buckwheat middlings, (6) linseed meal, (7) linseed meal and alfalfa hay, (8) wheat middlings and alfalfa hay and (9) skimmilk. With the exception of the skimmilk, 10 pounds of which was fed daily per pig, the corn and supplement in each case were self-fed in separate compartments of the feeders. The hay was fed in racks. During the trial the pigs were confined to pens of a central house having a concrete floor and could get nothing other than what was fed to them. Except those given meat meal, ground soybeans and buckwheat middlings as supplements to the corn, the lots were continued on the same feeds until May 9.

All lots were supplied with salt, ground limestone and ground rock phosphate, placed before them in separate compartments of containers so that they might take what they cared for of each. The amount of salt taken by the pigs in a lot ranged from 2 to 3 pounds. From 8 to 12 pounds of ground limestone and of ground rock phosphate were consumed by each lot.

As in Experiment III, the feed remaining in the feeders was weighed out at the time the weekly weights of the pigs were taken and the amounts of corn and the supplementary feed or feeds consumed each week determined. The results of 15 weeks' feeding are given in Table VI.

The pigs having skimmilk, tankage and meat meal as supplements gained in the order named and gained more rapidly than those fed the supplements derived from a vegetable source. The lot fed soybean oilmeal, however, gained only a little less rapidly than the one fed the meat meal. The pigs getting alfalfa in addition to linseed meal and corn gained 14 percent more rapidly than those allowed only linseed meal as a supplement.

For the first 7 weeks of the experiment, or until February 7, the pigs of Lot 5 ate practically no buckwheat middlings, their supplementary feed. During the eighth week they began eating the supplement and from then on ate it more readily. For the three weeks preceding February 7 they gained at the rate of thirty-two

hundredths of a pound daily and consumed 889.7 pounds of feed for each 100 pounds of gain. For the succeeding 3 weeks, during which they ate 32 pounds of the buckwheat middlings, they gained 1.11 pounds daily and required 391.5 pounds of feed for each 100 pounds of gain. On January 31 a pig was taken out of the lot and another put in its place. There is, of course, a possibility that the difference in rate and efficiency of gains was slightly influenced by the change. That it was not all the result of this is shown conclusively by the fact that for the week ending February 7 (during which time the new pig was in the lot) the average daily gain was five-tenths of a pound and the feed requirement 580.6 pounds per 100 pounds of gain while for the week beginning February 7 the daily gain per pig was eight-tenths of a pound and the amount of feed required for each 100 pounds of gain 435.1 pounds. During the latter week they ate 11 pounds of buckwheat middlings while during the former they ate none. After the pigs learned to eat the buckwheat middlings they also ate considerably more corn than before.

The proportions of feeds consumed by the pigs of the different lots are shown in Table VI. The relative amounts of corn and supplement taken by those having tankage, meat meal, soybean oilmeal or skimmilk were such that the resulting gains and feed requirements were fully equal to what might have been expected if the relative proportions of corn and the supplement used had been decided on by the feeder and the pigs given no choice in the matter. The pigs having wheat middlings and alfalfa hay, buckwheat middlings, linseed meal or ground soybeans as protein supplements did not consume sufficient quantities of these to balance the corn and so made slow and costly gains. These feeds, especially the latter two, were not palatable and the pigs never learned to eat them readily. As will be shown later better results are secured when the pigs are compelled to consume larger proportions of such feeds than they select of their own accord. The appetite or instinct of the pig does not enable it always to select the correct proportions of the feeds before it to give the optimum results that may be secured from those particular feeds.

In Table VII are given the results for each lot of Experiment IV to the time when the weekly weight of the lot was nearest an average of 175 pounds per pig. Before they reached this weight it was necessary to change the rations of Lots 4 and 5, fed respectively ground soybeans and buckwheat middlings as supplements. When summarized in this way the pigs allowed (1) skimmilk, (2)

TABLE VI.—EXPERIMENT IV: COMPARISON OF SUPPLEMENTS TO CORN FOR SELF-FEEDING IN DRY LOT

December 20, 1917, to April 4, 1918 (15 weeks)

Five pigs per lot	1 Corn and tankage	2 Corn and meat meal	3 Corn and soybean oilmeal	4 Corn and ground soybeans	5 Corn and buckwheat middlings	6 Corn and linseed meal	7 Corn, linseed meal and alfalfa hay	8 Corn middlings and alfalfa hay	9 Corn and skimmilk
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Average initial weight	55.1	55.0	55.2	55.1	55.2	54.9	55.1	54.9	55.3
Total gain	616.5	492.5	467.0	317.0	387.5	358.0	465.5	298.0	724.0
Average daily gain	**1.295**	**1.050**	**1.026**	**.604**	**.738**	**.775**	**.887**	**.655**	**1.379**
Feed consumed: corn	2,212.0	1,799.0	1,719.5	1,674.5	1,872.0	1,778.0	1,959.0	1,455.5	2,364.0
supplement	213.0	193.5	139.5	32.0	106.0	52.0	69.0	140.0	5,220.0
total concentrates	2,425.0	1,992.5	1,859.0	1,706.5	1,978.0	1,830.0	2,028.0	1,595.5	.....
hay	.....	.....	.....	.....	.....	.....	191.5	67.5	.....
Daily feed per pig: corn	4.647	3.836	3.779	3.190	3.566	3.848	3.731	3.199	4.503
supplement	.447	.413	.307	.061	.202	.113	.131	.308	10.0
hay	.....	.....	.....	.....	.....	.....	.365	.148	.....
Feed daily per 100 lbs. weight: concentrates	3.971	3.838	3.633	3.745	3.912	4.029	3.800	3.953	3.526
hay	.....	.....	.....	.....	.....	.....	.359	.167	7.831
Feed per 100 lbs. gain: corn	**358.800**	**365.279**	**368.201**	**528.233**	**483.097**	**496.648**	**420.838**	**488.423**	**326.519**
supplement	**34.550**	**39.289**	**29.872**	**10.695**	**27.355**	**14.525**	**14.823**	**46.980**	**725.138**
total concentrates	**393.350**	**404.568**	**398.073**	**538.328**	**510.452**	**511.173**	**435.661**	**535.403**	.....
hay	.....	.....	.....	.....	.....	.....	41.139	22.651	.....
Parts corn to supplement	10.4:1	9.3:1	12.3:1	52.3:1	17.7:1	34.2:1	28.4:1:2.8	10.4:1:.5	1:2.2

Lot 1, 86-pound pig was taken out on February 14.
Lot 2, 102-pound pig was taken out on February 7.
Lot 3, 70-pound pig and 87-pound pig were taken out January 31 and a 93-pound pig put in February 7.
Lot 5, 52-pound pig replaced with a 75.5-pound pig on January 31.
Lot 6, 65.5-pound pig was taken out on January 31.
Lot 8, 82.5-pound pig taken out January 24.

TABLE VII.—EXPERIMENT IV: COMPARISON OF SUPPLEMENTS TO CORN FOR SELF-FEEDING IN DRY LOT

Five pigs per lot	To a weight of 175 pounds						
	1 Corn and tankage	2 Corn and meat meal	3 Corn and soybean oilmeal	6 Corn and linseed meal	7 Corn, linseed meal and alfalfa hay	8 Corn middlings and alfalfa hay	9 Corn and skimmilk
Time required.....days..	91	105	112	133	126	140	84
Average initial weignt.....pounds..	55.1	55.0	55.2	54.9	55.1	54.9	55.3
Total gain.....pounds..	531.5	492.5	514.0	461.0	608.5	425.0	598.5
Average daily gain.....pounds..	1.265	1.050	1.064	.803	.966	.731	1.425
Feed consumed: corn.....pounds..	1,914.0	1,799.0	1,909.0	2,357.0	2,595.0	2,085.5	1,875.5
supplement.....pounds..	190.5	193.5	146.5	67.0	84.0	186.0	4,200.0
total concentrates.....pounds..	2,104.5	1,992.5	2,055.5	2,424.0	2,679.0	2,271.5	.....
hay.....pounds..	.....	.....	.....	.....	183.0	87.5	.....
Daily feed per pig: corn.....pounds..	4.557	3.836	3.953	4.106	4.119	3.590	4.465
supplement.....pounds..	.454	.413	.303	.117	.133	.320	10.0
hay.....pounds..	.....	.....	.....	.....	.290	.151	.....
Feed daily per 100 pounds weight:							
concentrates.....pounds..	4.258	3.838	3.596	3.798	3.667	3.362	3.878
hay (or milk).....pounds..	.....	.....	.....	.....	.251	.130	8.684
Feed per 100 pounds gain: corn.....pounds..	360.113	365.279	371.401	511.280	426.459	490.706	313.367
supplement.....pounds..	35.842	39.289	28.502	14.534	13.804	43.765	701.754
total concentrates.....pounds..	395.955	404.568	399.903	525.813	440.263	534.471	.....
hay.....pounds..	.....	.....	.....	.....	30.074	20.588	.....
Parts corn to supplement.....	10:1	9.3:1	13:1	35.2:1	30.9:1:2.2	11.2:1:4.7	1:2.2

Lot 1, 86-pound pig was taken out on February 14.
Lot 2, 102-pound pig was taken out on February 7.
Lot 3, one 70-pound and one 87-pound pig were taken out on January 31; a 93-pound pig was put in on February 7.
Lot 6, 65.5-pound pig was taken out on January 31.
Lot 8, 82.5-pound pig was taken out on January 24.

TABLE VIII.—EXPERIMENT IV: SUMMARY FROM APRIL 4 TO APRIL 25, 1918

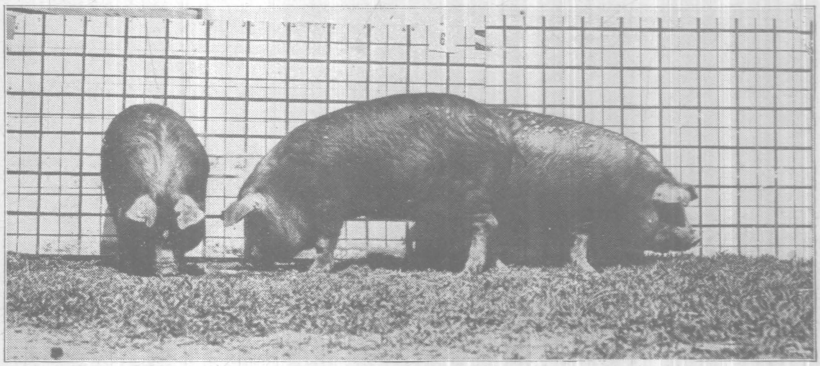
	1 Corn and tankage	2 Corn and meat meal	3 Corn and soybean oilmeal	4 Corn and ground soybeans	5 Corn and buckwheat middlings	6 Corn and linseed meal	7 Corn, linseed meal and alfalfa hay	8 Corn, middlings and alfalfa hay	9 Corn and skimmilk
Number of pigs per lot April 4	4	4	4	5	5	4	4	4	5
Average initial weight ..... pounds..	201.5	166.375	169.75	118.5	137.4	141.75	148.2	122.5	200.1
Average daily gain ..... pounds..	1.554	—.155	1.256	.424	.648	1.00	1.362	.940	.914
Feed per 100 pounds gain: corn ..... pounds..	424.521	.....	480.095	840.449	556.693	539.286	444.755	496.835	525.0
supplement ..... pounds..	24.138	.....	20.853	8.989	42.520	8.333	10.490	36.709	1,093.750
total concentrates ..... pounds..	448.659	.....	500.948	849.438	599.213	547.619	455.245	533.544	.....
hay ..... pounds..	.....	.....	.....	.....	.....	.....	16.783	3.797	.....

A 117-pound pig was taken out of Lot 5 on April 18.
Lot 2 consumed 196 pounds of corn and 16 pounds of meat meal.

tankage, (3) soybean oilmeal, (4) meat meal, (5) linseed meal and alfalfa hay, (6) linseed meal and (7) wheat middlings and alfalfa hay ranked in the order in which the supplements are named both in rate of gain and in the economy of feed required per unit of gain.

Table VIII gives a summary of the results secured for the 3 weeks from April 4 to April 25, at which time it became necessary to change the rations fed to some of the lots.

For the week ending April 18 one of the pigs of Lot 2 lost in weight. During the following week three lost in weight and the fourth gained nothing. At this time all four pigs remaining in the lot were constipated and lame or partially paralyzed posteriorly. The meat meal it will be remembered is composed largely of mus-



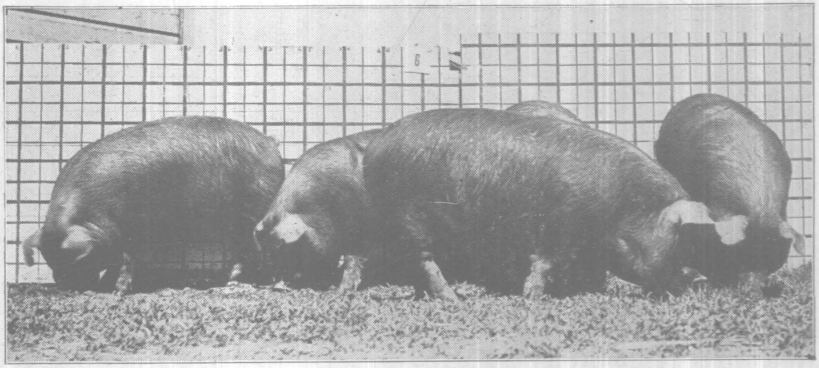
Lot 6, Experiment IV: Self-fed corn and linseed meal; average daily gain .78 pound. Notice broken down condition of front pasterns

cular tissue. It contains only a little over a third as much ash or mineral matter and a considerably higher percentage of fat than is found in tankage. It may be that the meat meal became slightly rancid before the experiment was completed but since during the fourteenth week of the experiment the preceding winter two pigs in the lot fed meat meal became lame and lost in weight, the indications are that the trouble was due to a deficiency in the ration rather than to digestive disorders caused by any rancidity of the meat meal.

All of the pigs of Lot 3 gained in weight until April 25. From then until May 9, however, one gained nothing and three lost in weight. During this time they, like the others, were constipated and lame, being able to rise on their hind feet only with difficulty. The exertion of rising pained them severely.

It will be noticed from Tables VI and VIII that Lot 4, given ground soybeans as a supplement, ate very little feed at any time other than the corn. With the exception of one pig during the last week all five gained in weight from April 4 to April 25, but the rate of gain was low. Since three became lame during the week ending April 25 the ration for the lot was changed on that date.

During the week ending April 11 two pigs of Lot 5 lost in weight. Both were lame posteriorly and were constipated. One of these became worse and was taken out the following week. Two others gained poorly the next week ending April 25 so that at that time the ration was changed.



Lot 7, Experiment IV: Self-fed corn, linseed meal and alfalfa hay; average daily gain .89 pound. Notice strength of pasterns as compared with those of the pigs of Lot 6

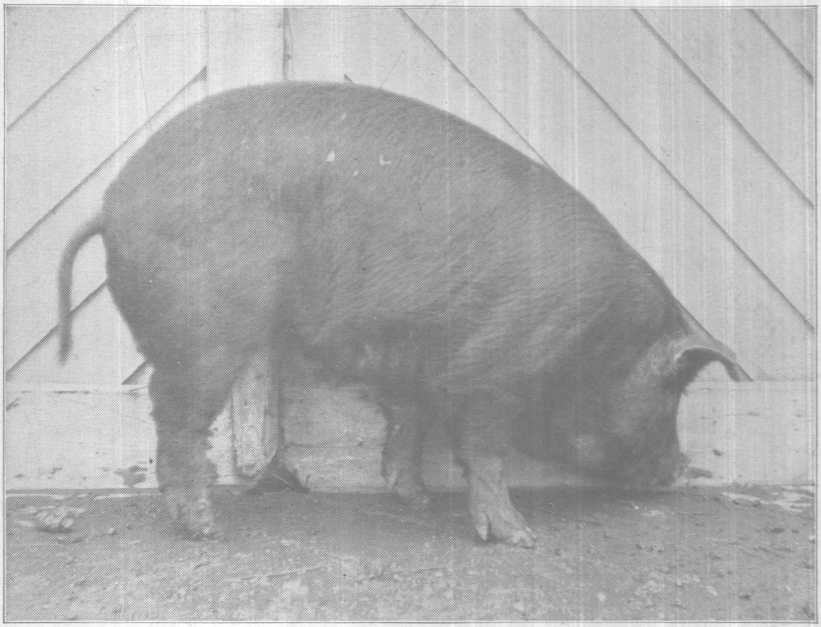
Six weeks after the beginning of the experiment a pig was taken out of Lot 6 because of lameness and constipation. None of the other pigs gained well and the feed requirement per unit of gain was high but with the exception just mentioned no other abnormal conditions occurred until the week ending May 9 when one pig lost in weight and two others gained only five-tenths of a pound and 3 pounds, respectively.

With the exception that one pig had a light attack of scours early in the experiment no digestive disturbances or abnormal conditions were experienced by the pigs of Lot 7.

At the close of the fifth week of the test one pig was taken out of Lot 8 because of an external injury. One pig in the lot did poorly and was taken out on April 25. There was no visible symptoms or indications of abnormality. When it was killed, however, it was found to be badly infested with intestinal worms. Although

the pigs did not eat much of either the middlings or the alfalfa the others in the lot remained healthy and in good physical condition.

From February 14 to April 25, the eighth to the eighteenth week, when it was taken out, one pig in Lot 9 lost 1.5 pounds in weight, losing during some weeks and gaining slightly at other times. This made the showing for the lot much poorer than otherwise it would have been during this time. The symptoms were not so marked but in other respects were like those shown by the pigs in the other lots. The pig was constipated at times and was somewhat lame.



Side view showing characteristic pose, if compelled to stand, of a pig suffering from paresis of the posterior limbs. In dry lot feeding lameness of this kind frequently results when the only supplement used is a nitrogenous concentrate of plant origin

A study of the results will show that with the possible exception of two pigs, in different lots, the pigs receiving (1) tankage, (2) skimmilk or (3) a high protein feed from a vegetable source together with alfalfa hay (Lots 1, 9, 7 and 8) suffered no ill effects from the rations allowed them. On the other hand, with the exception of one pig, those allowed a cereal or cereal by-product or the meat meal, which consisted largely of muscular tissue as the sole supplement to the corn, failed to continue to do well until marketed.

The pigs having some of these feeds as a supplement to the corn gained slowly and required a large amount of feed per unit of gain from shortly after the beginning of the experiment. Those having meat meal and soybean oilmeal gained at a fair rate and made economical gains for a considerable period of time. None of these feeds, however, continued to maintain the physical well being of the pigs.

COMPARISON OF SUPPLEMENTS FOR HAND-FEEDING IN DRY LOT

EXPERIMENT V

In Experiment V tankage, fish meal, buckwheat middlings, cocoanut meal, corn germ meal, peanut meal and linseed meal were compared as supplements to corn for hand-feeding pigs confined in dry lots. Two lots received corn germ-meal and two linseed meal. In addition to the nitrogenous concentrate one of those that received corn germ-meal and one of those that received linseed meal were allowed clover hay in a rack. Ground corn was fed. The feeds were mixed in the proportions shown in Table IX. All the lots were full-fed or given what they would clean up readily twice daily. The pigs were from 80 to 95 days of age at the beginning of the experiment, and averaged 56.8 pounds in weight at that time. Prior to the test they were allowed to run on bluegrass pasture and were all fed corn and tankage.

Salt, ground limestone and ground rock phosphate or floats were placed before all the pigs in separate containers. Lots 4, 5 and 6, fed respectively cocoanut meal, corn germ-meal and peanut meal as the supplemental feed, took more of the minerals and Lot 7, fed linseed meal, more of the ground limestone but no more of the floats than the lots receiving tankage, fish meal or skimmilk as the supplement or than those having access to clover hay.

At the time the proportions of supplements to use were decided upon some of the feeds had not been analyzed. It was thought the fish meal would contain a smaller percentage of protein than the tankage and so a larger proportion of it was used.

Except for Lot 3, the data for which are presented in Table XI, the results obtained are given in Table IX.

Fish meal proved a valuable supplemental feed. It produced gains at a higher rate and with a lower feed consumption per pound of gain than did tankage. This more favorable showing may have been at least partially the result of feeding a larger proportion of

TABLE IX.—EXPERIMENT V: COMPARISON OF SUPPLEMENTS TO CORN FOR HAND-FEEDING IN DRY LOT

December 10, 1918, to April 1, 1919

Five pigs per lot	1 Corn, 12; tankage, 1	2 Corn, 9; fish meal, 1	4 Corn, 2.5; cocoanut meal, 1	5 Corn, 2; corn germ meal, 1	6 Corn, 6; peanut meal, 1	7 Corn, 5.5; linseed meal, 1	8 Corn, 7; linseed meal, 1; clover hay	9 Corn, 3; corn germ meal, 1; clover hay
Average initial weight....pounds..	57.0	57.2	56.1	56.6	56.8	57.3	57.1	56.9
Total gain....pounds..	811.0	909.0	547.5	498.5	743.0	753.0	745.5	587.5
Average daily gain....pounds..	1.448	1.623	.978	.890	1.327	1.345	1.331	1.051
Feed consumed: corn....pounds..	2,786.308	2,880.9	1,709.643	1,317.0	2,424.429	2,398.423	2,496.813	1,773.75
supplement....pounds..	232.192	320.1	683.857	658.5	404.071	436.077	356.687	591.25
total concentrates....pounds..	3,018.5	3,201.0	2,393.5	1,975.5	2,828.5	2,834.5	2,853.5	2,365.0
clover hay....pounds..	.....	.....	.....	.....	.....	.....	544.0	394.0
Daily feed per pig: corn....pounds..	4.975	5.144	3.053	2.352	4.329	4.283	4.459	3.175
supplement....pounds..	.415	.572	1.221	1.176	.722	.779	.637	1.058
clover hay....pounds..	.....	.....	.....	.....	.....	.....	.971	.705
Feed daily per 100 pounds weight: concentrates....pounds..	3.903	3.860	3.856	3.314	3.853	3.817	3.871	3.652
clover hay....pounds..	.....	.....	.....	.....	.....	.....	.738	.608
Feed per 100 pounds gain: corn....pounds..	343.564	316 931	312.264	264.193	326.302	318.516	334.918	301.915
supplement....pounds..	28.630	35.214	124.905	132.096	54.384	57 912	47.845	100.638
total concentrates....pounds..	372.195	352.145	437.169	396.289	380.686	376.428	382 763	402.553
clover hay....pounds..	.....	.....	.....	.....	.....	.....	72.971	67.064

A 42-pound pig was taken out of Lot 9 on December 17 and a 44-pound pig put in its place on December 18.

the fish meal than of the tankage. The difference was greater at first than later. From an average weight of 97 pounds to 221 pounds, those fed tankage and those fed fish meal gained at the rates of 1.59 and 1.63 pounds daily per head and required 392.8 and 391.6 pounds of feed per 100 pounds of gain, respectively. With 100 pounds of gain, equal in price to 10 bushels of corn, and with the supplements valued at twice the price of corn, the value of the gains for this period over the value of the feed consumed was 3.1 percent greater for the lot fed tankage than for the lot fed fish meal.

The pigs of Lot 7 receiving linseed meal as a supplement gained 98.89 percent as rapidly and consumed only 1.14 percent more feed per unit of gain than those receiving tankage. This is a much better relative showing in comparison with the tankage than was made by the linseed meal when used as a supplement in Experiments III and IV, in which the linseed meal produced gains at a rate averaging only 73.24 percent as much and with a feed requirement per unit of gain averaging 18.04 percent higher than those resulting from the use of rations containing tankage. Such good results from linseed meal cannot ordinarily be expected. Those secured in Experiments VI and VII are more nearly typical of the relative results to be expected from rations containing tankage and linseed meal.

There was no advantage in either the rate or economy of gains in giving clover hay to pigs fed linseed meal. The clover used was rowen or clover grown in wheat stubble after the wheat had been taken off. It was cut late in the fall, was short, consisted largely of leaves and fine stems and had cured out somewhat dark in color. The pigs wasted rather large quantities of it. This as well as what they ate was charged against them.

In the case of the corn germ meal no concentrates were saved by the use of the clover, but the rate of gain was increased.

Toward the close of the thirteenth week one pig in Lot 6, receiving peanut meal as the supplement, became affected with the piles. From then to the close of the experiment (2 weeks) it lost in weight. The comparative results for Lots 6 and 7 for the first 13 weeks of the experiment are given in Table X. During this time those fed peanut meal gained 4.4 percent more rapidly and required 3.5 percent fewer pounds of feed per unit of gain than those fed linseed meal.

Both so far as the rate of gain and the feed consumption per unit of gain were concerned, cocoanut meal and corn germ meal proved less valuable than the other supplements used.

TABLE X.—EXPERIMENT V: COMPARISON OF SUPPLEMENTS TO CORN FOR HAND-FEEDING IN DRY LOT

Five pigs per lot	To a weight of 175 pounds					
	1 Corn, 12; tankage, 1	2 Corn, 9: fish meal, 1	6 Corn, 6; peanut meal, 1	7 Corn, 5.5; linseed meal, 1	8 Corn, 7; linseed meal, 1: clover hay in rack	9 Corn, 3; corn germ-meal, 1; clover hay in rack
Time required ..... days..	91	77	91	91	91	112
Average initial weight ..... pounds..	57.0	57.2	56.8	57.3	57.1	56.9
Total gain ..... pounds..	583.5	587.5	591.0	566.0	572.5	587.5
Average daily gain ..... pounds..	1.282	1.529	1.299	1.244	1.258	1.051
Feed consumed: corn ..... pounds..	2,070.923	1,714.95	1,853.143	1,815.423	1,893.5	1,773.75
supplement ..... pounds..	172.577	190.55	308.857	330.077	270.5	591.25
total concentrates ..... pounds..	2,243.5	1,905.5	2,162.0	2,145.5	2,164.0	2,365.0
clover hay ..... pounds..	.....	.....	.....	.....	457.5	394.0
Daily feed per pig: corn ..... pounds..	4.552	4.454	4.073	3.990	4.162	3.173
supplement ..... pounds..	.379	.495	.679	.725	.594	1.058
hay ..... pounds..	.....	.....	.....	.....	1.005	.705
Feed daily per 100 pounds weight: concentrates ..... pounds..	4.275	4.265	4.100	4.140	4.159	3.652
clover hay ..... pounds..	.....	.....	.....	.....	.879	.608
Feed per 100 pounds gain: corn ..... pounds..	354.914	291.410	313.561	320.746	330.742	301.915
supplement ..... pounds..	29.576	32.379	52.260	58.318	47.249	100.638
total concentrates ..... pounds..	384.490	323 789	365.821	379.064	377.991	402.553
clover hay ..... pounds..	.....	.....	.....	.....	79.983	67.064

A 42-pound pig was taken out of Lot 9 on December 17 and a 44-pound pig put in its place on December 18.

Table X gives the results for each lot to the time when its weekly weight averaged nearest 175 pounds per pig and shows the number of days that were required for this weight to be reached. When the experiment closed Lots 4 and 5 did not average 175 pounds in weight. After the thirteenth week the ration for Lot 3 was changed. The records for these three lots were necessarily omitted from the table.

Because of the poor response made by the pigs fed tankage during the first part of the experiment, which possibly was due to an inadequate supply of supplement for pigs of their age, the tankage fed pigs made a rather poor showing in comparison with those fed fish meal.

To a weight of 175 pounds the peanut meal gave even better results than the tankage. As a supplement to corn it was superior to the other feeds of plant origin used in the experiment.

Allowing the pigs fed linseed meal and corn germ-meal access to clover hay at first increased their rate of gain and decreased their concentrate requirement per unit of gain. The difference, however, even during this time was not great enough to pay for the hay used.

TABLE XI.—EXPERIMENT V: COMPARISON OF TANKAGE AND BUCKWHEAT MIDDLINGS

December 10, 1918 to February 25, 1919.

Five pigs per lot	1 Corn, 12; tankage, 1	3 Corn, 4.5; buckwheat middlings, 1
Average initial weight ..... pounds..	57.0	56.1
Total gain ..... pounds..	494.0	367.*
Average daily gain ..... pounds.	1.283	1.154
Feed consumed: corn ..... pounds..	1,665.692	1,133.591
supplement ..... pounds..	138.808	251.909
total ..... pounds..	1,804.5	1,385.5
Daily feed per pig: corn ..... pounds..	4.326	3.565
supplement ..... pounds..	.361	.792
Feed daily per 100 pounds weight ..... pounds..	4.405	4.357
Feed per 100 pounds gain: corn ..... pounds..	337.184	308.880
supplement ..... pounds..	28.899	68.640
total ..... pounds..	365.283	377.520

*A pig weighing 77.5 pounds was taken out of Lot 3 on December 20.

For the first 10 weeks of the experiment the pigs of Lot 3 having buckwheat middlings as a supplement did well. They gained at the rate of 1.2 pounds daily. During the tenth week one pig was constipated and became lame posteriorly. It gained nothing for the week. The following week all of the pigs were lame. One of these lost in weight and another gained nothing. The average daily gain for the week was forty-five hundredths of a

pound. Because of lameness and loss in weight one pig was taken out of the lot March 6. For the week from March 4 to 11 one pig lost 3.5 pounds and another gained only one-half pound. Since at the close of this time only one pig remained that continued to do well the ration was changed to corn and tankage.

Table XI compares the results secured from feeding buckwheat middlings and tankage as supplements to corn for the first 11 weeks of the experiment.

EXPERIMENT VI

Experiment VI was conducted to secure additional information on the relative values of various nitrogenous feeds already used in one or more experiments, to determine the value of dried milk albumen as a supplemental feed and to study the effect of adding a small amount of tankage to a ration of corn and linseed meal. The pigs used were purebred Duroc-Jerseys. With the exception of one, 13 days younger, they were from 107 to 121 days old at the beginning of the experiment. They then averaged 81.67 pounds in weight. Previous to the beginning of the test all received corn, middlings and tankage; some were self-fed the three feeds in separate compartments of the feeders, while others were hand-fed a ration of corn 7 parts, middlings 3 parts, tankage 1 part. The supplements used and the results secured during a period of 12 weeks are given in Table XII.

The ration containing tankage was made up of 12 pounds of corn to 1 of tankage. From the beginning of the experiment until March 3, 12 parts of corn to 1 of fish meal were fed. At that time the fish meal on hand was exhausted and a new supply (delayed in shipment) was not secured until March 13. In the intervening 10 days corn alone was fed. From March 13 to the close of the test 10 percent of fish meal was used in the ration. During the time corn alone was fed the pigs consumed a little less feed but lacked only 1.5 pounds gaining as much as those receiving corn and tankage.

The ration containing fish meal produced more rapid gains and greater gains on a given amount of feed than the one containing tankage. The difference in favor of the fish meal occurred largely during the early part of the experiment. For the first 6 weeks of the test the tankage fed pigs consumed 11.1 percent more feed per unit of gain and gained 95 percent as rapidly as those receiving fish meal. During the last 6 weeks, however, the pigs having tankage as the supplemental feed gained a little more than those receiving fish meal and required less than 1 (.98) percent more feed for each

TABLE XII.—EXPERIMENT VI: FEEDS SUPPLEMENTARY TO CORN FOR FEEDING IN DRY LOT

January 2 to March 26, 1920	1 Corn, 12; tankage, 1	2 Corn and fish meal*	3 Corn, 1; skimmilk, 2	4 Corn, 6; linseed meal, 1	5 Corn, 30; linseed meal, 3; tankage, 1	6 Corn and soybean oilmeal†	7 Corn, 9; milk albumen, 1
Pigs per lot ..... number..	6	6	6	6	6	6	5
Average initial weight ..... .pounds..	81.75	81.833	81.833	81.667	81.75	81.833	80.9
Total gain..... . pounds..	893.5	900.5	732.5	587.0	831.0	406.0	673.5
Average daily gain..... . ....pounds..	1.773	1.787	1.453	1.165	1.649	.806	1.604
Feed consumed: corn.....pounds..	3,108.462	3,005.746	2,262.	2,195.143	2,865.441	1,754.207	2,064.15
supplement.....pounds..	259.038	227.754	4,524.	365.857	286.544‡ 95.515§	254.793	229.35
total.....pounds..	3,367.5	3,233.5	.....	2,561.0	3,247.5	2,009.0	2,293.5
Daily feed per pig: corn.....pounds..	6.168	5.946	4.488	4.355	5.685	3.481	4.915
supplement.....pounds..	.514	.452	8.976	.726	.569‡ .189§	.505	.546
total.....pounds..	6.682	6.416	.....	5.081	6.443	3.986	5.461
Feed daily per 100 pounds weight....pounds..	4.277	4.090	. . . .	3.853	4.267	3.446	3.683
Feed per 100 pounds gain: corn .....pounds..	347.897	333.786	308.805	373.960	344.818	432.071	306.481
supplement.....pounds..	28.992	25.292	617.611	62.326	34.842‡ 11.494§	62.757	34.054
total.....pounds..	376.889	359.078	... .	436.286	390.794	494.828	340.535

A pig weighing 125 pounds was taken out of Lot 4 on February 27 and one 15.5 pounds heavier put in its place.

*An average of 13.2 pounds of corn to 1 of fish meal was fed. See text, page 158.

†For the first 8 weeks and the subsequent 4 weeks one-seventh and one-tenth of the ration, respectively, was composed of soybean oilmeal. This amounted to an average for the entire time of 6.9 pounds of corn to 1 of the meal.

‡Linseed meal.

§Tankage.

unit of gain produced. The results of this and the other experiment in which they were compared indicate that for young pigs fish meal is even more valuable than tankage but that for older pigs there is very little difference in the supplemental value of the two feeds.

While the pigs fed corn and skimmilk failed to gain as rapidly as the ones fed corn and tankage they required slightly less dry matter for each 100 pounds of increase in live weight. During the first half of the experiment they gained more than the tankage-fed pigs, but during the last half two pigs in the lot made an average gain of less than a pound a day and only one gained as much as 2 pounds daily, the average of the tankage fed lot for the same period. A tendency to scour at times was shown by some of the pigs fed the skimmilk. Although the decided difference in gain in favor of the tankage-fed pigs is at variance with the relative gains ordinarily made by pigs fed rations containing the two supplements, in other instances (see Bulletin 316) rations of corn and skimmilk have sometimes failed to produce as rapid gains during the latter part as during the fore part of the feeding period.

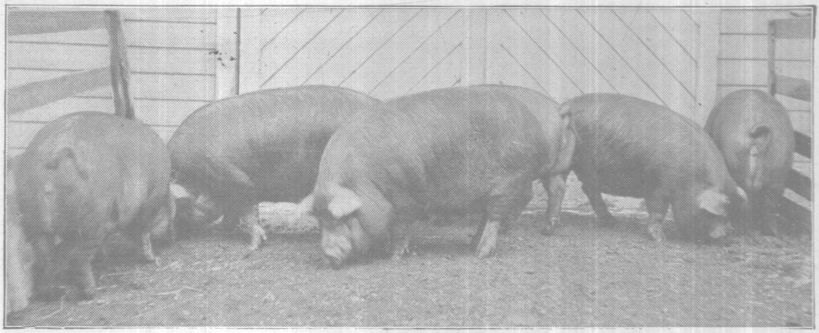
Dried milk albumen, a by-product of milk sugar factories, is dried skimmilk from which milk sugar has been removed. It is high in ash and contains approximately 45 percent of protein. The lot receiving it did not gain as rapidly as the lot receiving fish meal or either lot receiving tankage but, in comparison with those of the other lots, their feed requirement was remarkably low. Apparently milk albumen is a supplemental feed worthy of consideration. Its supply, of course, will always be rather limited.

The relative results from feeding tankage and linseed meal were typical of what may be expected from the use of the two feeds for supplementing corn in dry lot feeding. The pigs that received linseed meal gained 65.7 percent as much as those fed tankage and consumed 15.76 percent more feed for each unit of gain produced.

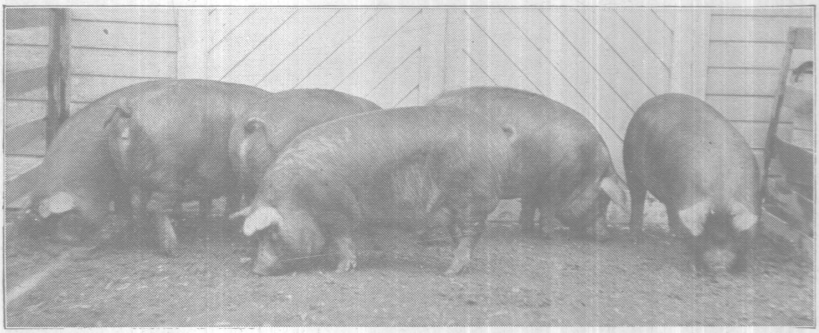
For the first 8 weeks 6 parts of corn to 1 of soybean oilmeal were fed. After that a ration of 9 parts of corn to 1 of the meal was used. In neither rapidity of gains nor feed requirement per unit of gain did the soybean oilmeal show as well in comparison with the tankage as it had in former dry lot experiments. According to analyses made by the Department of Dairying the soybean oilmeal used in the earlier tests contained 49 percent of protein and 3.2 percent of fat and that fed in Experiment VI, 40.5 percent of protein and 11.8 percent of fat. Judging from the results secured from the two grades a meal that is high in protein and low in oil is to be preferred to one that contains a larger proportion of oil.

TABLE XIII.—EXPERIMENT VI: EFFECT OF SUPPLYING GROUND ROCK PHOSPHATE AND LIMESTONE

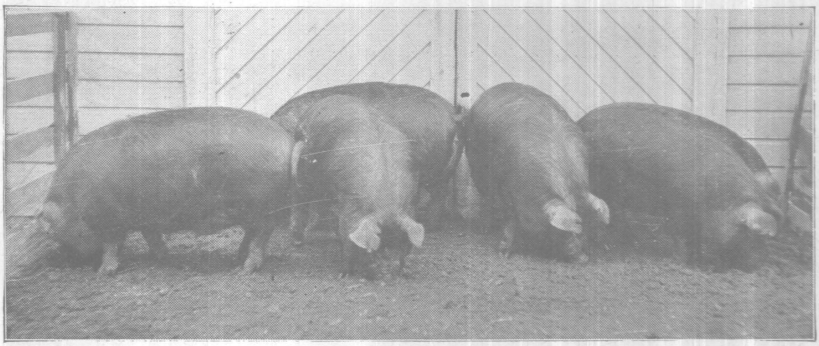
	January 2 to February 13		February 13 to March 26			
	Corn; linseed meal; salt	Corn; soybean oilmeal; salt	Corn; linseed meal; salt	Corn; linseed meal; salt; limestone; floats	Corn; soybean oilmeal; salt	Corn; soybean oilmeal; salt; limestone; floats
Pigs per lot.....number..	6	6	3	3	3	3
Average initial weight.....pounds..	81.667	81.833	135.333	130.0	118.167	115.167
Average final weight.....pounds..	132.667	116.667	182.833	181.333	145.667	153.333
Average daily gain.....pounds..	1.214	.829	1.008	1.222	.655	.909
Daily feed per pig.....pounds..	4.921	3.794	5.135	5.349	3.734	4.623
Feed per 100 pounds gain: corn.....pounds..	347.389	392.071	436.670	375.139	505.143	452.433
supplement.....pounds..	57.890	65.345	72.779	62.523	65.523	56.301
total.....pounds..	405.229	457.416	509.449	437.662	570.303	508.734



Lot 1, Experiment VI: Corn, 12; tankage, 1. Average gain 1.77 pounds

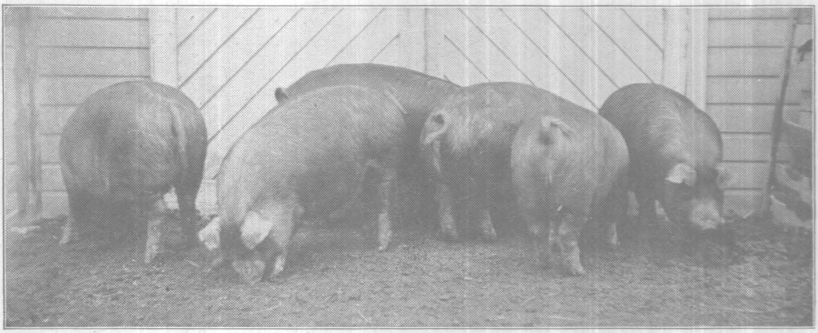


Lot 2, Experiment VI: Corn and fish meal; average daily gain 1.79 pounds

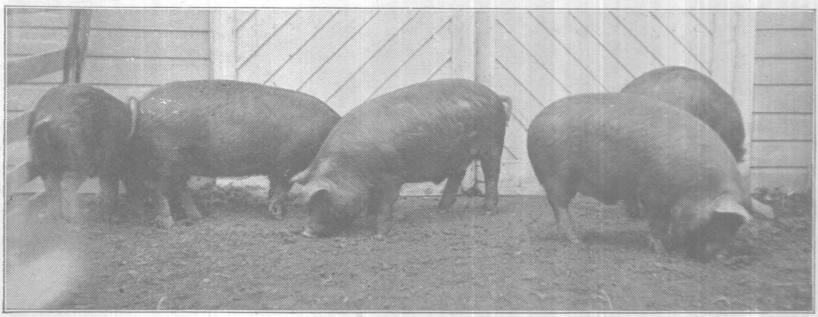


Lot 3, Experiment VI: Corn, 1; skimmilk, 2. Average daily gain 1.45 pounds

Lot 4, Experiment VI: Corn, 6; linseed meal, 1. Average daily gain 1.16 pounds



Lot 5, Experiment VI: Corn 30; linseed meal, 3; tankage, 1. Average daily gain 1.65 pounds



Lot 6, Experiment VI: Corn and soybean oilmeal; average daily gain .81 pound

IMPROVING RATIONS SUPPLEMENTED WITH FEEDS OF PLANT ORIGIN

MINERALS ADVANTAGEOUS

Twice each week during the first half of the experiment a little salt was given to all the lots but no other minerals were supplied. The pigs getting linseed meal and soybean oilmeal were then divided and half of each lot was given access to ground limestone and ground rock phosphate or floats, placed in separate containers. Otherwise they were fed just as they had been. As shown in Table XIII, allowing limestone and floats proved beneficial in both cases. Since one is a carrier of calcium and the other of both calcium and phosphorus further tests would be necessary to determine which of the two elements, or whether both, were responsible for the better showing made by the pigs receiving the minerals.

In an earlier experiment two lots of six pigs each, that averaged 54 pounds in weight at the beginning, were self-fed corn and soybean oilmeal separately for a period of 14 weeks. One was given no minerals while the other was allowed salt, ground limestone and floats in separate containers. Although the former took 1 pound of the supplement to 11.2 pounds of corn and the latter only 1 pound to every 16.6 pounds of corn, those getting no minerals gained only 52.8 percent as much and consumed 13.67 percent more feed for each unit of gain produced.

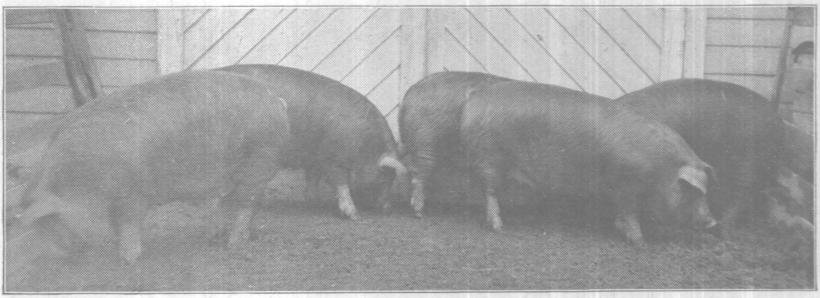
When tankage, fish meal, dairy by-products, leguminous hays or feeds having a high ash content are used, inorganic minerals are not so essential; but, when nitrogenous feeds of vegetable origin that carry only a small percentage of ash are fed to pigs that are confined in dry lot, the use of minerals, especially carriers of sodium, chlorine and calcium, the elements in which the grains are likely to be deficient, is recommended.

ADDITION OF A LITTLE TANKAGE OR SIMILAR FEEDS BENEFICIAL

Table XIV reports an earlier experiment in which better results were secured from corn supplemented with linseed meal and a little tankage than from a ration in which only linseed meal was used to supplement the corn. For the purpose of obtaining additional information on the effect of adding a small amount of tankage to a ration of corn and linseed meal one group of pigs (Lot 5, Table XII) was given a mixture of corn 30 parts, linseed meal 3 parts, tankage 1 part.

Compared with the corn and linseed meal ration, a marked increase in the rate of growth and a substantial saving in feed for each unit of increase in live weight resulted from substituting a little tankage for a part of the linseed meal. The gain was 41.5 percent greater and only 89.6 percent as much feed for each unit of gain was required. Neither as rapid gains nor as much gain from a given amount of feed, however, were secured from corn, linseed meal and tankage as were secured from corn and tankage.

While fish meal, the dairy by-products and similar feeds have not been tried and while tankage has not been used in a similar way with other supplements presumably these as well as tankage will improve rations of grain and any of the nitrogenous concentrates of plant origin.



Lot 7, Experiment VI: Corn, 9; dried milk albumen, 1. Average daily gain 1.6 pounds

EXPERIMENT VII

Linseed meal when used as the sole supplement to corn for feeding pigs in dry lot gives much better results than are secured from feeding corn alone, but does not give results equal to those obtained when such supplements as tankage or skimmilk are used. The object of Experiment VII was to determine the effect of adding a small amount of tankage to a ration of linseed meal and a carbonaceous feed such as corn when used for feeding pigs in dry lot. The pigs used were divided into three lots and fed rations of corn and tankage, of corn and linseed meal and of corn, linseed meal and tankage. They were purebred Duroc-Jerseys ranging from 10 to 14 weeks of age and averaging 41.6 pounds in weight at the beginning of the experiment. During the test they were confined in outside pens, the dimensions of which were 20 by 50 feet, and were provided with A houses for shade and shelter. The pens contained

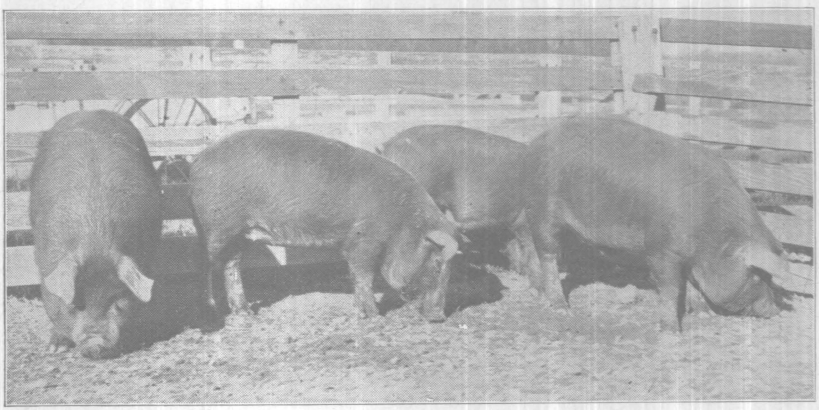
no green feed. Table XIV shows the number of pigs that were in each lot, the rations and proportions of feeds used and the results secured.

TABLE XIV.—EXPERIMENT VII: TANKAGE AND LINSEED MEAL AS SUPPLEMENTS TO CORN

July 24 to November 13, 1918

	1 Corn, 14; tankage, 1	2 Corn, 6; linseed meal, 1	3 Corn, 28; linseed meal, 3; tankage, 1
Pigs per lot.....number..	4	5	5
Average initial weight.....pounds..	42.0	41.5	41.4
Total gain.....pounds..	399.0	388.5	539.0
Average daily gain.....pounds..	.891	.782	.962
Feed: corn.....pounds..	1,511.067	1 518.857	2,034.812
supplement.....pounds..	107.933	253.143	218.016*
			72.672†
total.....pounds..	1,619.0	1 772.0	2 325.5
Daily feed per pig.....pounds..	3.614	3.565	4.153
Feed per 100 pounds gain: corn.....pounds..	378.713	390.954	377.516
supplement.....pounds..	27.051	65.159	40.448
			13.483*
total.....pounds..	405.764	456.113	431.447†

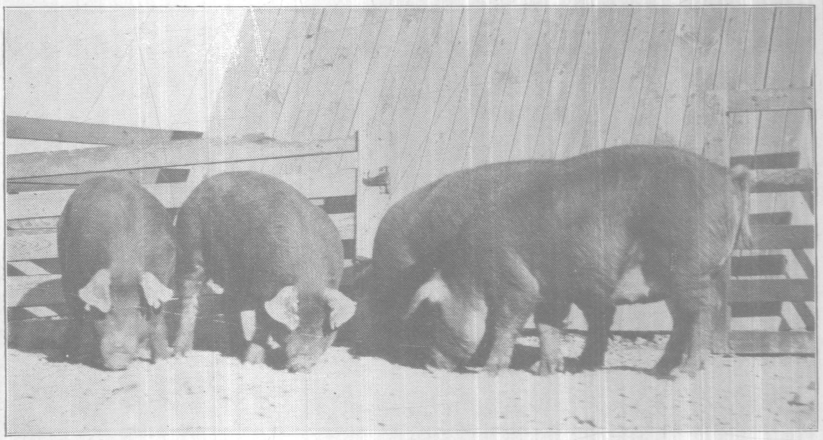
A 26-pound pig was taken out of Lot 2 on September 11.
*Linseed meal.
†Tankage.



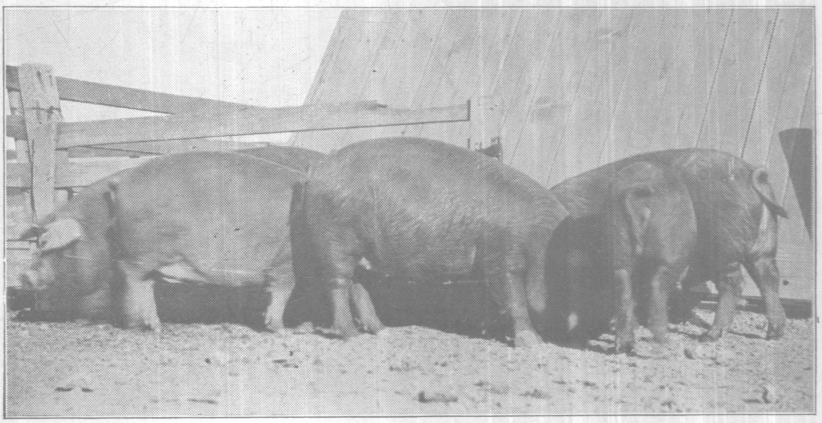
Lot 1, Experiment VII: Corn, 14; tankage, 1. Average daily gain .89 pound

The rations containing tankage produced more rapid gains than the one containing only linseed meal as a supplement. The lot fed corn and tankage required fewer pounds of feed per unit of gain than either of the others. Three percent of tankage in a

ration of corn and linseed meal increased the rate of gain 23 percent and decreased the feed required per unit of gain 5.4 percent. Whenever nitrogenous concentrates of plant origin are fed to pigs having no green feed the use of a small amount of skimmilk, buttermilk, tankage or some other high-protein feed from an animal source in connection with it is urged.



Lot 2, Experiment VII: Corn, 6; linseed meal, 1.
Average daily gain .78 pound



Lot 3, Experiment VII: Corn, 28; linseed meal, 3; tankage, 1.
Average daily gain .96 pound

EXPERIMENT VIII

LEGUMINOUS HAY SOMETIMES HELPFUL

Table XV shows the poor results secured from feeding corn alone to pigs that have no pasture and the effect of supplementing the corn with clover hay and with tankage. The pigs used were purebred Duroc-Jerseys ranging from 95 to 114 days of age at the time the test was begun. The three lots were given what corn or concentrates they would clean up readily twice daily. The clover hay was bright and green but contained a rather large proportion of stems and was not as leafy as was desired. It was placed in a rack so that the pigs receiving it could take whatever amount they cared for. All the pigs were given access to salt, ground limestone and floats placed before them in separate containers.

TABLE XV.—EXPERIMENT VIII: COMPARISON OF CLOVER HAY AND TANKAGE FOR SUPPLEMENTING CORN

July 4 to October 31, 1919

	1 Corn alone	2 Corn and clover hay	3 Corn, 12; tankage, 1
Pigs per lot.....number..	3	3	5
Average initial weight.....pounds..	66.833	68.0	66.8
Total gain.....pounds..	180.0	262.0	875.5
Average daily gain.....pounds..	.504	.734	1.170
Feed: corn.....pounds..	1,054.5	1,341.5	2,323.385
tankage.....pounds..	.....	.....	193.615
total concentrates.....pounds..	1,054.5	1,341.5	2,517.0
hay.....pounds..	.....	65.0	.....
Daily feed per pig: corn.....pounds..	2.954	3.758	4.425
supplement.....pounds..	.....	.182	.369
Concentrates daily per 100 pounds weight pounds..	3.050	3.365	3.356
Feed per 100 pounds gain: corn.....pounds..	585.833	512.023	378.402
tankage.....pounds..	.....	.....	31.533
total concentrates.....pounds..	585.833	512.023	409.935
hay.....pounds.	.....	24.809	.....

A 72.5-pound pig was taken out of Lot 3 on August 22.

Feeding it alone to pigs getting no forage is a wasteful and inefficient method of utilizing corn. With the relative prices of corn and hogs that usually exist the small resulting gain in weight is not usually sufficient to pay for the corn consumed in producing it. The younger the pigs are, the larger is the proportion of supplement needed and the greater the beneficial effect from its use.

The pigs allowed hay gained more rapidly, consumed more feed and required fewer pounds of corn per unit of gain produced than those fed corn alone. Hay, however, is so fibrous and bulky in character that pigs are incapable of consuming sufficient quantities of feed to make rapid gains if it constitutes any considerable portion of the ration. Since liberal amounts are needed to balance

the grain, although its use in connection with corn was an improvement over corn alone, clover was not as effective as tankage for supplementing corn.

With tankage valued at twice as much and clover at half as much as an equal weight of corn, the gains produced from a bushel of corn or its equivalent in cost by the lot fed corn alone, corn and hay, and corn and tankage, were 9.6, 10.7 and 12.7 pounds, respectively.

RATION IMPROVED BY MIXING IF SUPPLEMENT IS UNPALATABLE

EXPERIMENT IX

In Experiments III and IV it was found that pigs self-fed corn and linseed meal separately ate a very small proportion of the linseed meal. Experiment IX was conducted to determine whether better results could not be secured by feeding a mixture of the two feeds and compelling the pigs to take a larger proportion of the linseed meal than they consume when allowed the same feeds self-fed separately.

The pigs used in the experiment were crossbred Duroc-Jersey-Tamworths ranging from 21 to 24 weeks of age at the beginning of the experiemnt and averaging 120.65 pounds in weight at that time. During the trial they were kept in half-acre plots which previously had been in rape and pastured with lambs but at the time used contained very little green feed of any kind. The plots were mowed to prevent the rape from producing new growth. There were 5 pigs in each lot. Both lots were self-fed. One was given ground corn and linseed meal in separate compartments of the feeder and the other a mixture of ground corn 6 parts, linseed meal 1 part. The test was continued for 49 days with the results as shown in Table XVI.

TABLE XVI.—EXPERIMENT IX: SELF-FEEDING LINSEED MEAL

September 25 to November 13, 1918

	1 Corn and linseed meal, self-fed separately	2 Corn, 6; linseed meal, 1; self-fed
Average initial weight.....pounds..	121.5	119.8
Total gain.....pounds..	415.5	525.0
Average daily gain.....pounds..	1.696	2.143
Feed consumed: corn.....pounds..	1,721.7	1,730.971
linseed meal.....pounds..	66.7	296.829
total.....pounds.	1,788.4	2,077.800
Average daily feed: corn.....pounds..	7.028	7.269
linseed meal.....pounds..	.272	1.212
total.....pounds..	7.300	8.481
Feed daily per 100 pounds weight.....pounds..	4.477	4.922
Feed per 100 pounds gain: corn.....pounds..	414.368	339.232
linseed meal.....pounds..	16.053	56.539
total.....pounds..	430.421	395.771
Parts corn and linseed.....pounds..	25.8:1	6:1

The pigs fed the mixture ate a larger total amount of feed daily per head, ate more feed daily per unit of weight, gained 26.35 percent more rapidly and required 8.05 percent less feed for each 100 pounds of gain produced than those offered the corn and linseed meal separately. Those having each of the two feeds before them took only 1 part of the linseed meal to 25.8 parts of corn.

For the first week of the trial the pigs fed the mixture ate less total feed than the others but in proportion to the corn the amount of linseed meal they were compelled to take was almost 2½ times as great as that consumed by the "free choice" fed pigs. After that, however, with the exception of 1 week, Lot 2, given the mixture, ate more feed than Lot 1, which was offered the two feeds separately and the latter lot ate a still smaller proportion of supplement.

The appetite does not always assist the animal in selecting the proper proportions of the feeds available to give the best results possible from the use of those feeds. Although it has not been verified, presumably results similar to those secured from feeding linseed meal as the supplement to corn may be expected from the use of a number of the less palatable high-protein feeds, such as soybeans, buckwheat middlings, corn germ meal, gluten meal and copra or cocoanut meal.

While no direct comparison has been made to determine the relative gains and feed requirements per unit of gain, from feeding corn and soybeans in definite proportions and from feeding the two by a plan which permits the pigs to choose the proportions for themselves, possibly some indication of the relative results that may be expected from the two methods of feeding can be gained by comparing the records of the pigs in Experiment II with those of the pigs in Experiment III while they were of like weight. In the former experiment a ration of corn 24 parts, ground soybeans 5 parts, was fed. In the latter trial the corn and soybeans were self-fed separately. Table XVII gives the results obtained and compares these on a percentage basis with the results secured from the use of corn and tankage.

Compared with the pigs fed corn and tankage those of Experiment II, given corn and soybeans, gained 76.8 percent as rapidly and consumed 9.3 percent more feed per unit of gain while those of Experiment III gained 64.4 percent as rapidly and required 19.7 percent more feed per unit of gain. The lot which selected the proportion of soybeans for themselves took only 1 part of the beans to 38.4 parts of corn.

When given an opportunity to balance their own ration, pigs sometimes take an insufficient amount of the protein feed if it happens to be distasteful. Experiments are also on record in which, from the standpoint of financial economy at least, excessive amounts of the costly nitrogenous concentrates were consumed. Perhaps in these instances the protein feed was palatable while the carbonaceous feed was distasteful. Further tests are needed to determine whether pigs are likely to balance their own ration successfully, when the feeds allowed them are self-fed separately, should one or more of the feeds prove to be unpalatable.

TABLE XVII

	Experiment II		Experiment III	
	Corn, 9; tankage, 1	Corn, 24; ground soybeans, 5	Corn and tankage self-fed separately	Corn and ground soybeans self-fed separately
Average initial weight.....pounds..	103.75	103.5	108.167	100.5
Average final weight.....pounds..	180.375	172.125	174.5	168.833
Average daily gain.....pounds .	1.824	1.401	1.895	1.220
Feed per 100 pounds gain: corn.....pounds..	311.844	313.548	360.176	440.122
supplement.....pounds.	34.649	65.323	17.085	11.463
total.....pounds..	346.495	378.871	377.261	451.585
Relative rate of gain.....percent	100	76.8	100	64.4
Relative feed consumption per unit of gain..percent..	100	109.3	100	119.7

FORAGE ENHANCES VALUE OF PLANT SUPPLEMENTS

EXPERIMENT X

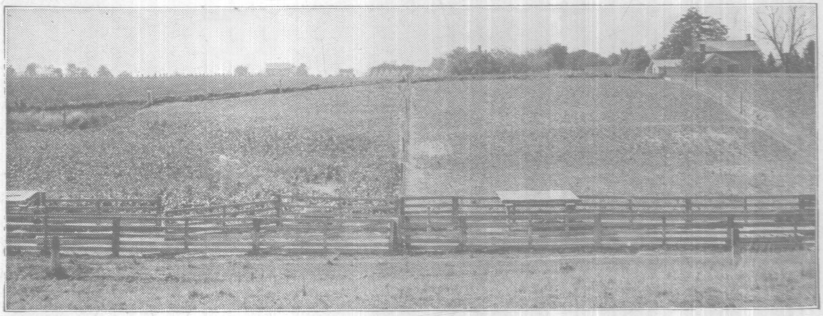
Experiment X was conducted for the purpose of comparing a number of supplements to corn for feeding pigs on forage. Tankage, corn germ meal, linseed meal, ground soybeans and middlings were the feeds compared. A sixth lot was given corn alone on forage and a seventh was fed corn and tankage but allowed no green feed. Purebred Duroc-Jersey pigs farrowed in March and April were used. The forage for each lot consisted of a quarter of an acre of rape pasture. At the time the experiment was begun the rape had reached a height of 10 to 12 inches. An abundance of green feed was supplied throughout the entire experiment, which was continued for 15 weeks. Except those in dry lot, which were allowed all the grain they would clean up readily, the pigs were given slightly less than a full feed of concentrates. For those on forage the variation in the daily allowance for each 100 pounds of live weight did not exceed three-hundredths of a pound. Table XVIII gives the results of the test.

TABLE XVIII.—EXPERIMENT X: COMPARISON OF SUPPLEMENTS TO CORN FOR FATTENING SWINE ON FORAGE

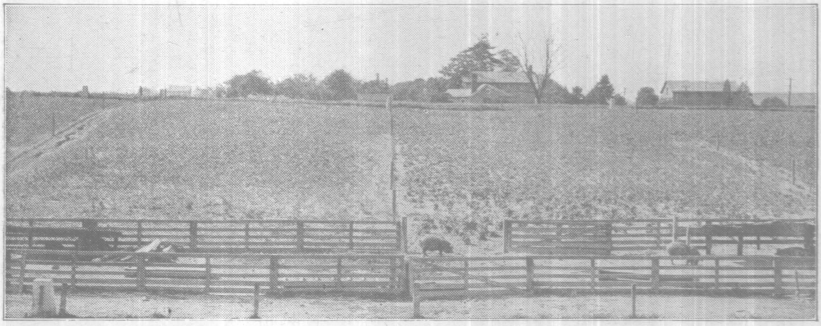
June 17 to September 30, 1918

	1 Corn alone	2 Corn, 19; tankage, 1	3 Corn, 3; corn germ meal, 1	4 Corn, 8; linseed meal; 1	5 Corn, 7; ground soybeans, 1	6 Corn, 2; middlings, 1	7 Corn, 9; tankage, 1 Dry lot
Pigs per lot.....number..	5	6	6	6	6	5	5
Average initial weight.....pounds..	62.4	59.75	60.0	60.4	59.75	59.6	61.4
Total gain.....pounds .	598.0	869.5	787.0	849.5	800.5	585.0	658.0
Average daily gain.....pounds	1.139	1.380	1.249	1.348	1.271	1.300	1.253
Concentrates consumed: corn.....pounds	2,335.4	2,903.77	2,179.65	2,677.867	2,534.35	1,455.333	2,329.65
supplement.....pounds	.....	152.83	726.55	334.733	362.05	728.167	258.85
total.....pounds	2,335.4	3 056.60	2,906.20	3,012.600	2,896.40	2,184.500	2,588.50
Daily concentrates per pig: corn.....pounds.	4.448	4.609	3.460	4.251	4.032	3.236	4.437
supplement.....pounds.	.....	.243	1.153	.531	.574	1.618	.493
total.....pounds	4.448	4.852	4.613	4.782	4.597	4.854	4.930
Concentrates daily per 100 pounds weight.....pounds..	3.640	3.665	3.673	3.645	3.631	3.650	3.876
Concentrates per 100 pounds gain: corn.....pounds	390.535	333.958	276.957	315.229	316.596	248.946	354.050
supplement.....pounds.	.....	17.577	92.319	39.403	45.228	124.473	39.339
total.....pounds	390.535	351.535	369.276	354.632	361.824	373.419	393.389
Yield in dressed weight*.....percent	77.87	78.13	75.86	75.61	76.12	74.20	77.49

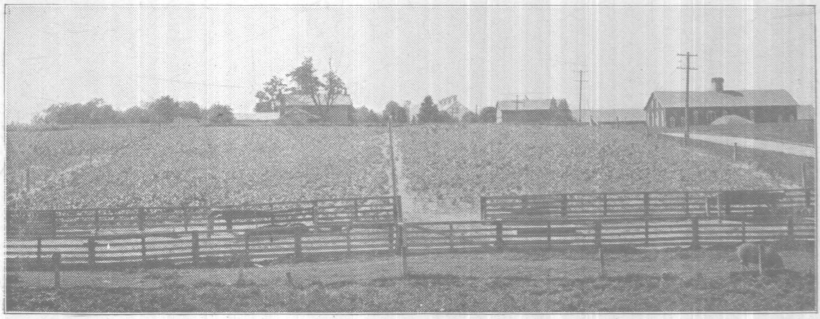
A 57.5-pound pig in Lot 6 died July 17.
*Based on live weight before shipping and warm dressed weight.



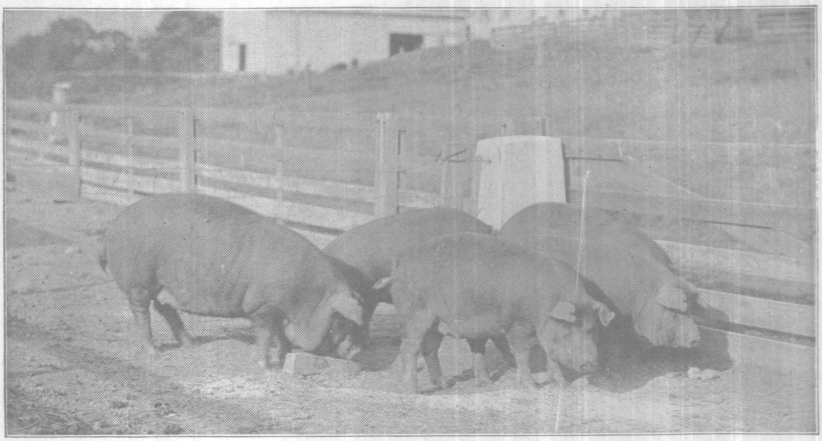
Plots grazed by Lots 1 and 2 (left to right), Experiment X, showing condition of forage at close of experiment



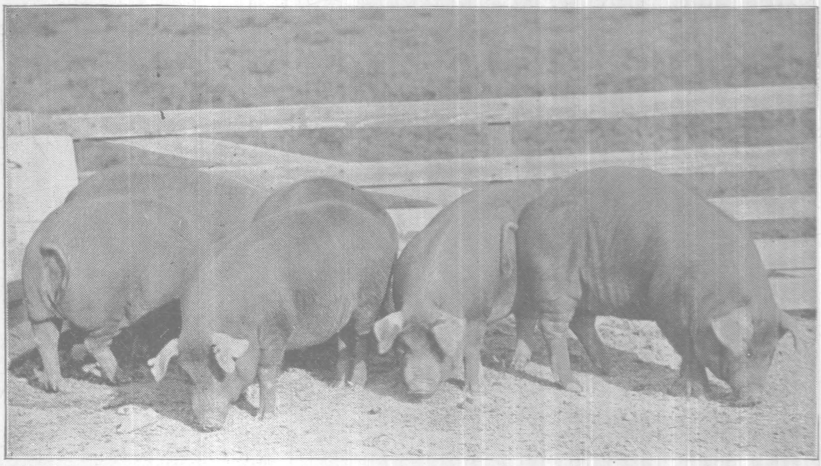
Plots grazed by Lots 3 and 4 (left to right), Experiment X, showing condition of forage at close of experiment



Plots grazed by Lots 5 and 6 (left to right), Experiment X, showing condition of forage at close of experiment

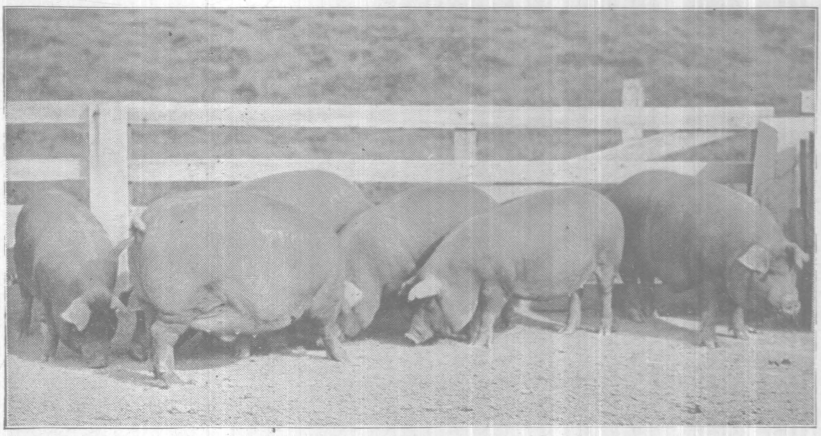


Lot 1, Experiment X: Corn alone on rape pasture. Average daily gain 1.14 pounds

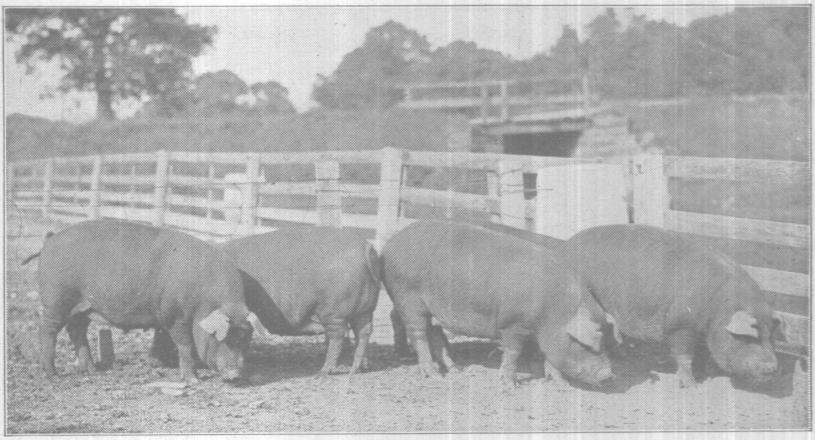


Lot 2, Experiment X: Corn, 19; tankage, 1, on rape pasture. Average daily gain 1.38 pounds.

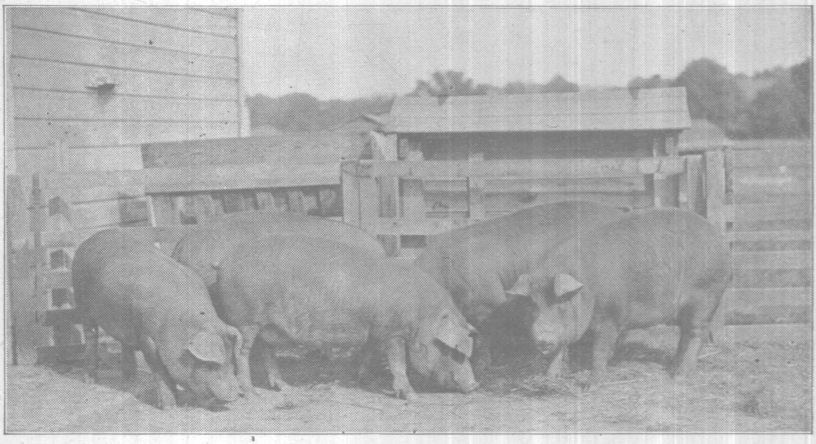
Lot 3, Experiment X: Corn, 3; corn germ meal, 1, on rape pasture. Average daily gain 1.25 pounds



Lot 4, Experiment X: Corn, 8; linseed meal, 1, on rape pasture. Average daily gain 1.35 pounds



Lot 5, Experiment X: Corn, 7; ground soybeans, 1, on rape pasture. Average daily gain 1.27 pounds



Lot 7, Experiment X: Corn, 9; tankage, 1; dry lot. Average daily gain 1.25 pounds

Of the lots on forage all those fed a supplemental feed with corn gained more rapidly and required fewer pounds of feed per unit of gain than the pigs fed corn alone. Those fed corn and tankage ranked first in both rate of gain and feed requirement per unit of gain. The tankage given averaged a little less than a quarter of a pound daily per pig.

While the pigs fed corn and tankage gained more rapidly and consumed fewer pounds of concentrates per unit of gain than those fed any of the other rations, the protein supplements derived from a plant source made a much better comparative showing with tankage than they did in dry lot feeding or when no forage was used. The linseed meal particularly compared favorably with the tankage in every respect.

The differences in dressing percentages indicate the possibility of the dressed yields having been influenced somewhat by the amount of crude fiber in the ration. As the proportion of fiber increased the yields in dressed weight decreased. More evidence would be needed to prove the relationship a causal one.

Since summaries for each lot, from the beginning of the experiment to the time average weights equal to that of the average final weight of the slowest-gaining lot, showed no changes in the relative standings of the lots so far as feed consumption per unit of gain was concerned, no table giving the results to a definite weight is presented. From an initial weight of 60 pounds, periods of 105, 92, 99, 96, 98, 100 and 99 days were required for the pigs of the lots that received respectively no supplement, tankage, corn germ meal, linseed meal, ground soybeans, middlings and tankage with no green feed to reach a weight of 180 pounds. The ones making the most rapid gains reached that weight 13 days sooner than those of the lot making the slowest gains.

EXPERIMENT XI

Experiment XI compares a ration of corn alone with others containing (1) tankage, (2) linseed meal, (3) buckwheat middlings, (4) soybean oilmeal and (5) ground soybeans as supplements to corn for feeding pigs on forage. In addition to these there were two lots that received no green feed. One was given a ration of corn alone and the other a ration of corn and tankage. At the beginning of the experiment the pigs averaged 67 pounds in weight and, with the exception of one pig 2 weeks younger, were from 94 to 114 days of age. Rape pasture was used as forage. Each lot having forage was placed on a quarter-acre plot which supplied green feed throughout the test. Table XIX gives the results obtained.

TABLE XIX.—EXPERIMENT XI: COMPARISON OF SUPPLEMENTS TO CORN FOR FEEDING ON FORAGE

July 4 to October 17, 1919.

	1	2	3	4	5	6	7	8
	Corn alone	Corn, 19; tankage, 1	Corn, 8; linseed meal, 1	Corn, 6; buckwheat middlings, 1	Corn, 12; soybean oilmeal, 1	Corn, 8; ground soybeans, 1	Corn alone dry lot	Corn, 12; tankage, 1; dry lot
Average initial weight.....pounds..	67.3	66.6	66.9	67.5	67.7	67.5	66.8	66.8
Final weight.....pounds..	756.5	1,120.0	1,129.5	1,130.0	1,190.0	1,061.5	361.0	785.5
Total gain.....pounds..	485.0	787.	795.0	792.5	851.5	724.0	150.5	524.0
Average daily gain.....pounds..	1.102	1.499	1.514	1.510	1.622	1.379	.478	1.117
Concentrates consumed: corn.....pounds..	2,043.5	2,793.0	2,679.556	2,596.714	2,891.077	2,600.444	916.0	1,953.231
supplement.....pounds..	.....	147.0	334.944	432.786	240.923	325.056	.....	162.769
total.....pounds..	2,043.5	2,940.0	3,014.5	3,029.5	3,132.0	2,925.5	916.0	2,116.0
Daily concentrates per pig: corn.....pounds..	4.644	5.320	5.104	4.946	5.507	4.953	2.908	4.165
supplement.....pounds..	.....	.280	.638	.824	.459	.619	.....	.347
total.....pounds..	4.644	5.600	5.742	5.770	5.966	5.572	2.908	4.512
Concentrates daily per 100 pounds weight.....pounds..	3.622	3.854	3.922	3.932	3.903	3.983	3.107	3.429
Concentrates per 100 pounds gain: corn.....pounds..	421.340	354.892	337.051	327.661	339.5	350.177	608.638	372.754
supplement.....pounds..	.....	18.679	42.131	54.610	28.294	44.897	.....	31 063
total.....pounds..	421.340	373.571	379.182	382.271	367.821	404.075	608.638	403.817

The results were similar to those secured in Experiment X. The pigs fed the supplemental feeds gained more rapidly and required fewer pounds of concentrates per unit of gain than those fed no nitrogenous supplement. With the exception of ground soybeans the results secured from feeding corn and the protein feeds of plant origin compared favorably with those secured from corn and tankage. The average rates of gain of the lots receiving tankage, linseed meal and buckwheat middlings as supplements varied less than 2 percent and the amounts of concentrates required per unit of gain by these three lots and the one fed soybean oilmeal as a supplement less than 4 percent. Five percent of tankage in the ration was perhaps too small a proportion, particularly during the first part of the test.

In a number of instances, in which corn was supplemented with a single protein feed of plant origin for feeding pigs confined in dry lots, the ration failed to maintain their physical well being so that after a longer or shorter time they broke down or became lame posteriorly. Nothing of this kind was encountered when any of these feeds were used with corn for feeding pigs on forage. In the two experiments in which buckwheat middlings were used to supplement corn in dry lot feeding the pigs became lame or partially paralyzed within 13 weeks from the time they were placed on feed. The pigs in the present experiment fed a similar ration but having forage with it were carried for 19 weeks with no ill effects.

Table XX gives a summary of the average results secured from supplementing corn with the various nitrogenous feeds of plant origin that were used in both the dry lot and forage experiments and compares these results with those of the corn and tankage fed pigs when carried to approximately the same weights. Since in Experiment IV the lots allowed soybeans and linseed meal took such small quantities of the supplements that they ate rations virtually of corn alone their records are not included in the summaries for the two supplements.

A study of the table will show that without exception the protein feeds of plant origin compare more favorably with tankage for supplementing corn when they are fed to pigs on forage than they do when fed to pigs that have no green feed.

TABLE XX.—RELATIVE RESULTS FROM SUPPLEMENTS OF PLANT ORIGIN AND FROM TANKAGE WHEN FED WITH CORN TO PIGS IN DRY LOT AND ON FORAGE

Location	Supplement	No. of lots	No. of pigs	Average initial weight	Average final weight	Average daily gain	Concentrates per 100 lbs. gain			Relative gain with tankage as 100%	Comparative feed per unit of gain with tankage as 100%
							Corn	Supplement	Total		
Dry lot	Linseed meal	4	22	59.5	179.8	1.152	375.1	47.7	422.8	83.3	111.7
	tankage	4	21	60.2	182.0	1.384	350.3	28.3	378.6		
Forage	Linseed meal	2	11	63.4	212.9	1.424	325.8	40.7	366.5	99.3	101.2
	tankage	2	11	63.0	213.5	1.434	343.9	18.1	362.0		
Dry lot	Ground soybeans	2	10	73.9	170.2	1.228	394.0	30.4	424.4	74.9	116.9
	tankage	2	10	73.6	176.8	1.639	333.0	29.9	362.9		
Forage	Ground soybeans	2	11	63.4	206.3	1.321	340.0	45.4	385.4	93.9	106.3
	tankage	2	11	63.0	205.3	1.407	344.4	18.1	362.5		
Dry lot	Soybean oilmeal	3	15	67.6	187.9	1.273	373.6	28.1	401.7	84.9	106.3
	tankage	3	15	67.4	189.1	1.500	346.7	31.1	377.8		
Forage	Soybean oilmeal	2	9	87.9	222.1	1.583	354.0	32.5	386.5	105.8	98.4
	tankage	2	9	88.4	221.1	1.496	368.9	23.7	392.6		
Dry lot	Buckwheat middlings	2	10	55.7	140.9	.869	406.6	50.4	457.0	72.5	118.8
	tankage	2	10	56.1	140.3	1.198	350.8	33.9	384.7		
Forage	Buckwheat middlings	1	5	67.5	226.0	1.510	327.7	54.6	382.3	100.7	102.3
	tankage	1	5	66.6	224.0	1.499	354.9	18.7	373.6		
Dry lot	Corn germ meal	1	5	56.6	156.3	.890	264.2	132.1	396.3	69.4	108.5
	tankage	1	5	57.0	155.8	1.283	337.2	28.1	365.3		
Forage	Corn germ meal	1	6	60.0	200.7	1.257	283.0	94.3	377.3	91.1	107.3
	tankage	1	6	59.7	204.8	1.380	333.9	17.6	351.5		

SUMMARY AND DEDUCTIONS

Although higher in protein, meat meal made from meat cuttings and consisting exclusively of muscular and fatty tissue did not give as good results in dry lot feeding as tankage.

For some reason skimmilk failed to show up so advantageously in comparison with tankage as it did in experiments previously reported. This difference was due to the relatively poor results secured from its use during the last half of both experiments, when the pigs fed corn and tankage made more rapid gains and consumed fewer pounds of dry matter per unit of gain produced than those fed corn and skimmilk.

In the one trial in which it was used, greater gains from a given amount of feed were obtained from the use of milk albumen than from the use of any of the supplements with which it was compared. The rate of gain, however, was not as high as that produced by some of the other feeds.

For young pigs fish meal proved even more valuable than tankage but for older pigs there was apparently very little difference in the supplemental value of the two feeds.

With the exception of one pig in Experiment IV that received skimmilk, the pigs given corn supplemented with tankage, fish meal, dried milk albumen and skimmilk remained in good physical condition and did not become crampy even after prolonged heavy feeding while confined in small pens of a central house floored with concrete. Those given meat meal as a supplement to corn did well for several weeks but, in both experiments, after being fed for a considerable period of time became lame posteriorly or lost partial control of their hind legs. The lameness was sometimes associated with a constipated condition.

While there was a wide variation in the supplemental value of the nitrogenous feeds from plant sources, with the exception of one instance in which soybean oilmeal gave slightly better results than meat meal, none of these were equal to the feeds of animal origin for supplementing corn in dry lot feeding.

Ground soybeans gave relatively poor results and were not a very satisfactory supplement. They were not palatable. When the pigs were self-fed the corn and beans separately they took very small quantities of the beans.

Soybean oilmeal that was low in fat or oil (3.2 percent) and high in protein proved to be one of the best supplemental feeds of plant origin tried. Results from feeding a soybean oilmeal with a higher fat content (11.8 percent) were disappointing. Evidently the oil contained in soybeans is detrimental as well as distasteful.

For dry-lot feeding linseed meal gave better results than soybeans but was not equal to soybean oilmeal. The rate of gain made by pigs fed linseed meal as the supplement ranged from 70.9 to 92.9 and averaged 83.3 percent that of the pigs fed tankage in comparison when they were carried to approximately the same weights. For each unit of gain produced they consumed from 1.1 to 16.7 or an average of 11.7 percent more feed than the tankage-fed pigs.

During the first parts of the two dry lot experiments in which it was used buckwheat middlings compared favorably with linseed meal. The pigs given corn and buckwheat middlings, however, showed an inclination to become partially paralyzed sooner than those given the other supplements of vegetable origin.

Corn germ meal and cocoanut meal when fed as the sole supplements to corn did not produce as good results as did linseed meal. They are not recommended for using alone with corn in dry lot feeding.

In the one test in which it was tried, peanut meal produced gains more rapidly and more economically than linseed meal. The meal is the ground residue of the kernels after oil has been extracted from them and should not be confused with peanut feed, which contains a part or all of the hulls and consequently is higher in fiber and less valuable. The hulls are of little or no worth as a feed.

Pigs fed corn and soybean oilmeal and given no salt or other minerals gained less rapidly and required more feed per unit of gain than others similarly fed but given access to salt, ground limestone and floats. Allowing ground limestone and floats improved rations of corn, linseed meal and salt and of corn, soybean oilmeal and salt. Since rations of grain supplemented with protein concentrates of plant origin are practically all low in ash presumably the use of salt and a carrier of calcium, minerals which contain the elements likely to be deficient, in connection with most if not all such rations will be found beneficial when these are fed to pigs confined in dry lots.

Although supplying the minerals designated with the rations mentioned increased the rate of gain and lowered the feed consumption per unit of gain, allowing access to salt, limestone and floats was not effective in preventing pigs fed corn supplemented with linseed meal, with soybean oilmeal, with other nitrogenous concentrates of vegetable origin or with meat meal from eventually breaking down or becoming lame in the manner already described.

Allowing pigs that were fed corn and linseed meal access to a leguminous hay proved to be advantageous in one experiment but not in another. Through the use of clover hay in connection with corn germ meal the rate of gain was increased. The concentrate requirement for each unit of increase in live weight was not materially changed. The pigs having hay also had access to salt, limestone and floats. While some of those in Experiment III that were given corn and linseed meal but no hay suffered from partial paralysis none of the pigs allowed clover or alfalfa in any of the tests broke down or became lame posteriorly. Because of its bulk hay (whole or ground) should not be used to form any considerable portion of rations for fattening swine; but giving pigs, fed grain and a supplemental feed low in ash, access to what bright green leguminous hay they care for may be found beneficial.

Much better results were secured from rations of corn and linseed meal to which a little tankage was added than from rations in which only linseed meal was used to supplement the corn. The effect of adding a small amount of tankage to such rations in producing more rapid gains and lowering the consumption of feed per unit of gain was striking. While tankage has not been used in the same way with other supplements derived from plants nor dairy by-products, fish meal or similar feeds tried, presumably these as well as tankage will improve rations of grain supplemented with any of the nitrogenous concentrates of plant origin. Hence, whenever supplements derived from plants are utilized in the feeding of pigs that have no forage, the addition of a small amount of one of the feeds named or some similar feed to the ration is recommended.

Although a smaller quantity is necessary than is needed in dry-lot feeding a small amount of some nitrogenous concentrate in the ration was beneficial for pigs on pasture.

Where forage was supplied the nitrogenous feeds of vegetable origin were satisfactory supplements to the corn. All of the high protein feeds derived from plants that were tried compared much more favorably with tankage when used for feeding pigs on forage than when used for feeding those that had no green feed. Some of them were as efficient as tankage when utilized in this way.

If unpalatable supplements are fed in such a manner that the pigs can select whatever proportions of the carbonaceous and protein feeds they care for they sometimes fail to take a sufficient amount of the supplement to balance the ration or to give the optimum results possible from the feeds used. This difficulty may be overcome by mixing the distasteful supplement with the grain or with a palatable protein feed.